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MEMORANDUM

To: Jason Gunter, U.S. Environmental Protection Agency
From: Marcia Greenblatt
Date: February 2014
Subject: Big River OU-2 Sediment Probing Survey
Project No.: C816

Sediment probing in Big River, Owl Creek, and Flat River Creek was performed from November 29 to December 1, 2012 to support the ongoing feasibility study in operable unit 2 (OU-2) (river and non-residential areas) of St. Francois County Mining Area (also referred to as Big River Mine Tailings Site), Missouri. The sediment probing survey was performed to support the identification and evaluation of potential remedial alternatives. The primary objective of sediment probing was to estimate current sediment volumes in depositional areas and in tributaries. The proposed approach to sediment probing was documented in the Field Sampling Proposal (FSP), Appendix A of the Quality Assurance Project Plan (QAPP) (Integral 2013a).

SUMMARY OF SEDIMENT PROBING ACTIVITIES

A sediment probing survey was performed to estimate sediment volumes in depositional areas and tributaries within the former mining areas. Targeted locations included 1) pooled or backwater areas to characterize sediment trapping potential and 2) tributaries previously surveyed in 2007 to estimate current sediment volumes (NewFields 2007). Locations for sediment probing were identified following a review of the Visual River Survey (VRS) observations and previous sediment volume surveys (Integral 2013b).

A review of the VRS observations indicated only one significant Big River backwater area where sediments may collect within OU-2, which was located at the Bone Hole. Three transects were performed at the Bone Hole: BRFSPP01, BRFSPP02, and BRFSPP03 (Figure 1, Table 1). Mining-related material was previously observed in two tributaries, Flat River Creek and Owl Creek (NewFields 2007), and these tributaries were resurveyed (transects

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FRCSP01 through FRCSP10 and transects OCFSSP01 through OCFSSP03). Two additional Big River sediment probing locations were added to the survey following the submittal of the FSP at the request of the U.S. Environmental Protection Agency (Gunter 2012, pers. comm.): one at St. Francois State Park and one at Blackwell. The Blackwell location was not surveyed because of access restrictions and a water depth that was too deep to safely wade (Integral 2013c). Four sediment probing transects were performed near St. Francois State Park (transects SFSP01 through SFSP04); these transects were performed in areas where depositional material was observed at the time of survey.

Field Approach

To estimate the average thickness of the sediment in the selected depositional areas, 20 cross-sections of Big River and selected tributaries were probed with a 3/8-in., 4.5-ft long rebar probe where sediments were present (Integral 2013a). The number and spacing of the cross-sections were determined based on the extent of the depositional area. At each river cross-section, five to eleven depth estimates were made by pushing the probe by hand from the surface of the sediment to refusal and measuring the penetration depth (Table 2). For the purposes of this study, sediments are defined as all material in the channel that occurs above the refusal depth or what is taken to be intact or broken bedrock (Integral 2013a). This definition includes main channel and off-channel deposits, both in and above the water level. The exposed gravel and sand bars that are common in Big River were included in the sediment probing transects.

The channel width, or cross-section length, was obtained using a hip chain. The length of the string pulled from the hip chain was measured (to the nearest foot) and recorded in the field logbook. Photographs were taken by the field team to document general observations and the condition of each probing area (Integral 2013c; Attachment A). At each location, a form was completed to document the probing transects, including layout, width, depth, and substrate composition information (Attachment B).

Data Evaluation

The probing data were used to estimate sediment volumes for each of the surveyed areas. The unit sediment volume (the volume per unit length) was calculated at each transect as the product of the average probing depth and the transect width (Table 3). The sediment volume between two successive transects (the segment volume) was calculated as the product of the average unit sediment volume of the upstream and downstream transects and segment length (the distance between adjacent transects) (Table 4). Segment lengths were measured along the channel centerline within a Geographic Information System (GIS)

using 2010 National Agriculture Imagery Program (NAIP) aerial photography (NAIP 2010). The sediment volumes for each segment were summed to estimate the total sediment volume in each area surveyed.

Results

The calculated sediment depths and volumes of each study area, as well as observations made during the survey, are briefly discussed below. Observed trends and calculated values are compared with previous sediment probing studies (NewFields 2007, MDNR 2007), and the Borrow Pit Monitoring Project (Owen et al. 2012).

Big River at the Bone Hole

Three sediment probing transects were performed from the confluence of Big River with Owl Creek to the low-water crossing at the Bone Hole (BRFSSP01 through BRFSSP03). Results from transects BRFSSP01 through BRFSSP03 indicated a depositional environment, with average sediment depths along the three transects of 1.9, 1.6, and 1.6 ft respectively (Table 3). The total sediment volume between the transects was estimated to be 547 yd³; the observed deposition is consistent with the low-water crossing slowing the flow of Big River and creating a depositional backwater area.

Collocated transects from the 2007 and 2012 surveys, BR-3 and BRFSSP03, had average sediment depths of a similar magnitude (1.75 and 1.6 ft, respectively), suggesting that the Bone Hole has stable sediment depths over time (Table 3) (NewFields 2007). This finding is consistent with results from the 2010 borrow pit study performed at the Bone Hole. The study was performed to characterize infilling potential following excavation of 508 yd³ of sediment (Owen et al. 2012). Post-excavation surveys indicated that the pit had filled to 80 percent of its previous volume following a 10-year flood event and had nearly completely refilled after several near-bankfull events; it was concluded that the channel sediment storage at the Bone Hole is relatively stable (Owen et al. 2012).

Big River at St. Francois State Park

Four sediment probing transects were performed in Big River adjacent to St. Francois State Park in which the 1,900 ft-long surveyed area contained approximately 22,000 yd³ of sediment (Figure 1, Table 4). Gravel and sand bars were observed in each St. Francois State Park probing transect and contained approximately 70 percent of the estimated volume. Each transect also had locations where sediment was probed to depths greater than 1 ft in the river channel. The sand and gravel bars as well as the river bottom of this stretch of Big River are an area where sediments are stored along Big River.

Average sediment depths along the transects adjacent to St. Francois State Park were similar or greater than those observed at the Bone Hole (Table 3). It is likely that the average sediment depths for transects SFSP01 and SFSP02 were underestimated because the probe did not reach refusal for several of the locations along these transects and, therefore, a sediment depth of 60 in. was assumed in the volume calculations (Table 2). Missouri Department of Natural Resources measured sediment depths with ground-penetrating radar (GPR) in a bar approximately 150 ft upstream of transect SFSP01; GPR data indicated sediment depths up to 9.7 ft (MDNR 2007).

Owl Creek

Sediment probing was performed along the lower 1,000 ft of Owl Creek at three transects, OCFSSP01 through OCFSSP03. Little sediment deposition was observed in the uppermost transect, OCFSSP01, and the creek bottom was scoured to bedrock at some locations along this transect (Table 2). Average sediment depth along Transect OCFSSP02 was greater than OCFSSP01, and the substrate primarily consisted of sandy silt and fines. A vegetated bar was observed in the center of OCFSSP02 and leaf litter was observed in Owl Creek at this location. Transect OCFSSP03 had an average sediment depth of 1.5 ft, the deepest of the Owl Creek transects; no sand or gravel bars were observed along OCFSSP03. The 2007 survey occupied approximately the same transects in Owl Creek and found a similar pattern of increasing sediment depths with distance downstream (NewFields 2007).

In 2007, the total estimated sediment volume in Owl Creek was 3,650 yd³ from the culvert at the abandoned Mississippi River and Bonne Terre railroad crossing to the confluence with Big River, approximately 1,200 ft downstream (Figure 1, Table 4) (NewFields 2007). In the current sediment survey this value was 1,206 yd³, indicating approximately a 3-fold decrease in sediment volume. NewFields (2007) used a different approach for volume calculation than in the current study: the Owl Creek transects were used as approximate midpoints to calculate volumes for three segments within this span (NewFields 2007). Applying this approach to the 2012 survey data, the sediment volume from the railroad crossing to the confluence of Owl Creek and Big River was approximately 1,660 yd³, less than one-half of the volume estimated in 2007. In 2007 the water was too deep to collect probing measurements at the lowermost transect (Owl Creek C-C'), and an average sediment depth of 3 ft was assumed (NewFields 2007), which could have led to an overestimate of sediment volume. In 2012 all locations along this transect were successfully probed and the average sediment depth was 1.5, one-half of the 2007 assumed value. Although the sediment volume in Owl Creek may have been overestimated in 2007 because of the estimated depth along the lower transect, the average sediment depths for the two upper Owl Creek transects were also higher in 2007 than in 2012, when the average depths

were less than 1 foot. Sediments observed in the Owl Creek reach in 2007 may have washed off from the small watershed, moved downstream from the upper reach, and potentially eroded from the Mississippi River and Bonne Terre Railroad crossing (NewFields 2007), located approximately 100 ft above the survey reach. Sediments observed in the upper reach of Owl Creek in 2007 were vegetated and appeared stable (NewFields 2007). The reduction in sediment volume could indicate that there is little or no ongoing erosion of the railroad crossing and that sediments have been washed out of the creek.

Flat River Creek

Ten sediment probing transects were performed in Flat River Creek from the drainage of the Elvins/Rivermines pile to the confluence with Big River. The majority of sediment in Flat River Creek was found in gravel and sand bars observed in transects FRCFSSP03, -05, -06 and -10 (Figure 1). Several of these bars were vegetated and appeared stable. Limited sediment was observed in the Flat River Creek channel and the creek bottom was scoured to bedrock in portions of several transects (FRCFSSP01, -02, -04, -05, -07, and -08) (Figure 1, Table 2). The patterns observed in the 2012 sediment probing survey were generally consistent with those observed in the 2007 study, where the only significant sediment accumulation was within gravel and sand bars (NewFields 2007).

The estimated sediment volume in the lower 5 miles of Flat River Creek was 21,000 yd³ in 2012 (Table 4). In 2007, only one complete sediment probing transect was performed (at FR-8 [FRCFSSP10]); measurements of gravel and sand bars observed between FR-4 and FR-7.5 (FRCFSSP01 and FRCFSSP09) were used to estimate a total sediment volume of 13,000 yd³. The observed difference in sediment volume could be due to the different survey techniques.

Source control measures via non-time critical removal actions (NTCRAs) have been established at the Elvins/Rivermines piles; stabilization of the National and Federal piles is ongoing (USEPA 2012). The stabilization measures will prevent mining-related material from entering Big River and its tributaries; completion of the NTCRAs is expected to lead to a decrease in Flat River Creek sediment loading in the future.

Summary

Sediment probing was performed to support sediment volume estimates in several reaches in Big River and its tributaries. The accumulation of sediment within Big River at the locations evaluated suggests that these locations act as long-term sediment traps. The

effectiveness of trapping and periodically removing sediments as a component of remediation will be evaluated in the Feasibility Study.

Sediment deposition patterns within Owl Creek and Flat River Creek were generally similar between the 2007 and 2012 probing surveys. Sediment was primarily stored in gravel and sand bars, some of which were vegetated and appeared stable. Given the dynamic hydrologic nature of Big River watershed (where flows can rise over an order of magnitude in less than a day), sediment volumes can be expected to vary over time. The ongoing remediation of the piles adjacent to Flat River Creek may result in a reduction of sediment supply following construction completion. Over time, a decline in sediment volume may be observable. Although the sediment load from the Flat River Creek watershed has not been evaluated, the sediment budget will be considered as part of the Feasibility Study.

REFERENCES

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LIST OF ATTACHMENTS

Figure 1. Sediment Probing Locations

Table 1. Locations and Coordinates of Sediment Probing Survey Transects

Table 2. Sediment Probing Survey Field Measurements

Table 3. Transect Average Sediment Depth and Unit Volume

Table 4. Estimated Sediment Volumes

Attachment A. Photos from 2012 Sediment Probing Survey

Attachment B. Field forms from 2012 Sediment Probing Survey

FIGURES

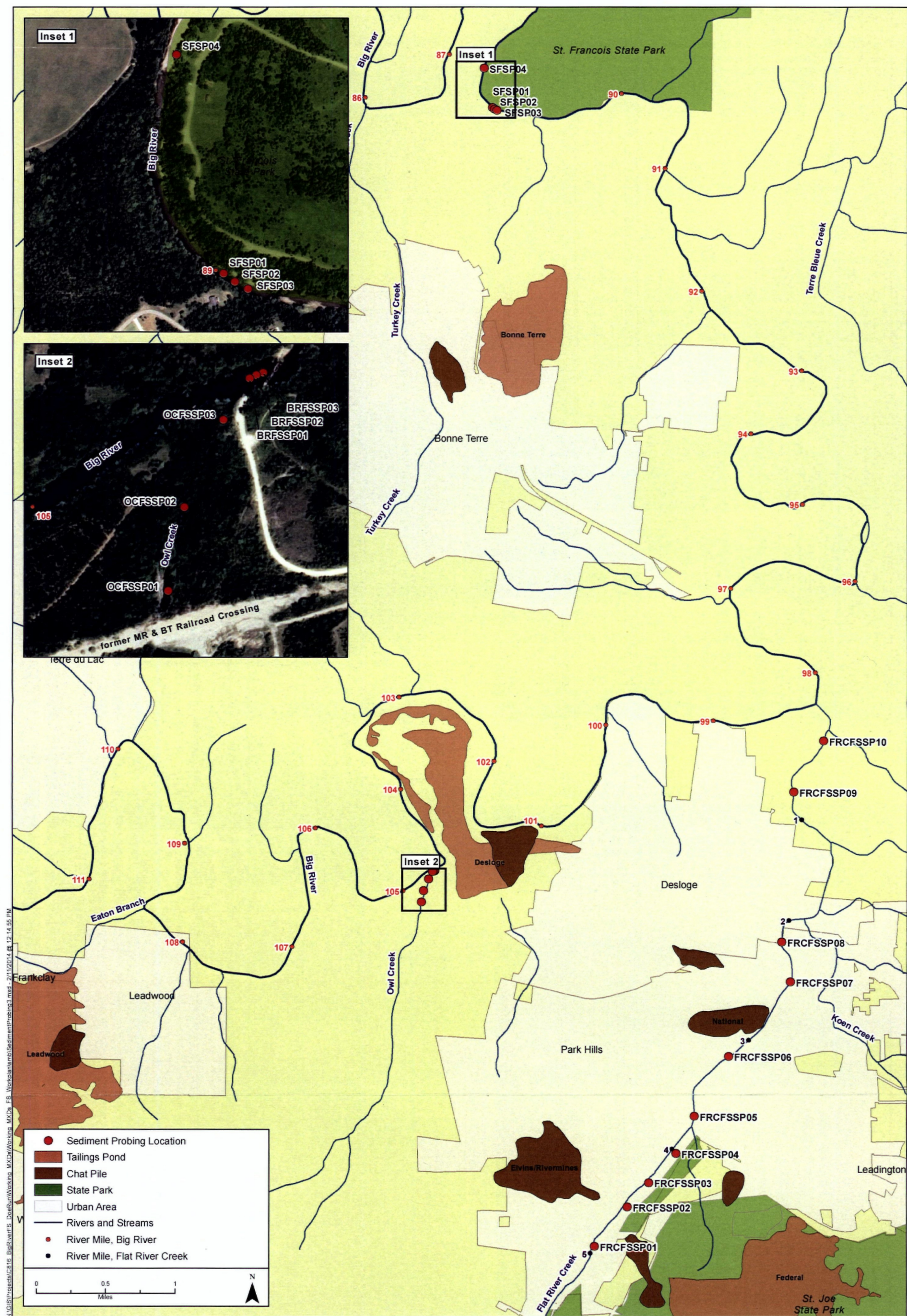


Figure 1.
Sediment Probing Locations
River and Non-Residential Areas (OU-2)
St. Francois County Mining Area, Missouri

TABLES

Table 1. Locations and Coordinates of Sediment Probing Survey Transects

Transect Number	Location	Longitude ^a	Latitude ^a
BRFSSP01	Big River at Bone Hole	-90.550700000	37.875220000
BRFSSP02	Big River at Bone Hole	-90.550582000	37.875264000
BRFSSP03	Big River at Bone Hole	-90.550462000	37.875297000
SFSP01	Big River at St. Francois State Park	-90.540230385	37.954617066
SFSP02	Big River at St. Francois State Park	-90.539963788	37.954455530
SFSP03	Big River at St. Francois State Park	-90.539655009	37.954313601
SFSP04	Big River at St. Francois State Park	-90.541207860	37.958735462
OCFSSP01	Owl Creek	-90.552234744	37.872289176
OCFSSP02	Owl Creek	-90.551908703	37.873450854
OCFSSP03	Owl Creek	-90.551181918	37.874653350
FRCFSSP01	Flat River Creek	-90.530685432	37.836008944
FRCFSSP02	Flat River Creek	-90.526226734	37.839986267
FRCFSSP03	Flat River Creek	-90.523338299	37.842441910
FRCFSSP04	Flat River Creek	-90.519660498	37.845405664
FRCFSSP05	Flat River Creek	-90.517131248	37.849211154
FRCFSSP06	Flat River Creek	-90.512417566	37.855413540
FRCFSSP07	Flat River Creek	-90.504091823	37.862988454
FRCFSSP08	Flat River Creek	-90.505106687	37.867138518
FRCFSSP09	Flat River Creek	-90.503051600	37.882675244
FRCFSSP10	Flat River Creek	-90.498998711	37.887894044

Note:

^a Coordinates are from the center of the probing transect and are reported in the World Geodetic System 1984 (WGS 1984).

Table 2. Sediment Probing Survey Field Measurements

Transect Number	Bank Width (feet)	Probed Sediment Depth (inches)										
		Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10	Depth 11 ^a
BRFSSP01	149	17	4	5	10	23	20	38	36	40	40	--
BRFSSP02	152	30	31	32	26	6	14	26	15	10	3	--
BRFSSP03	173	29	16	22	29	14	19	17	18	22	5	--
SFSP01	113	57.5	44	60 ^b	60 ^b	60 ^b	47	60 ^b	27.5	29	0	--
SFSP02	108.5	17.5	9.5	60 ^b	4.5	48	46	43	12	0	0	--
SFSP03	120.5	24	8.5	4	6	23	41	16	11	29	38	--
SFSP04	142.5	15	37	3	1.5	11	14	31	4	4	49	--
OCFSSP01	40	0	0	0	0	0	0	0	2	0.75	1.5	5
OCFSSP02	38	20	14.5	2.5	14.5	11.5	5	3	7	9.25	17	--
OCFSSP03	46	49	18.5	17	9	10.5	11	6.5	4	4	8	59
FRCFSSP01	74	9	7	7	6	0	0	0	0	0	10.5	--
FRCFSSP02	59	23	3.5	4.25	2	4.5	4.25	0	0	1.5	5	--
FRCFSSP03	72	2	3	4	2.5	4	2.75	3	2	5	5	--
FRCFSSP04	79.5	0.25	14.5	0	0	0	--	--	--	--	--	--
FRCFSSP05	70	7	26	9.5	18	11.5	29.5	3	0.5	0	9.5	--
FRCFSSP06	73	1	1.5	1.25	2	1.25	3	3	2	3	5	--
FRCFSSP07	29.5	6	4	3	5	4.5	0	0	0	0	0	--
FRCFSSP08	40	0	0	0	0	2	5	5	6.5	4.5	4	--
FRCFSSP09	36	5.25	5.5	5.5	8	3.5	4	2.5	8	10	14	--
FRCFSSP10	72	4.5	5	12	17.5	18	6	25	17	16	11	8.5

Notes:

^a A goal of 5 to 10 measurements at a sediment probing transect was proposed in the FSP; at some locations an additional transect was performed for better coverage of the area (Integral 2013c).

^b In cases where the probe did not reach refusal, a note was made and a depth value of 60 inches (maximum probe depth) was indicated.

Table 3. Transect Average Sediment Depth and Unit Volume

Transect Number	Bank Width (ft)	Average Sediment Depth (ft)	Unit Sediment Volume ^a (yd ³ /ft)
BRFSSP01	149	1.9	11
BRFSSP02	152	1.6	9.1
BRFSSP03	173	1.6	10
SFSP01	113	3.7	16
SFSP02	108.5	2.0	8.1
SFSP03	120.5	1.7	7.5
SFSP04	142.5	1.4	7.5
OCFSSP01	40	0.1	0.10
OCFSSP02	38	0.9	1.2
OCFSSP03	46	1.5	2.5
FRCFSSP01	74	0.3	0.90
FRCFSSP02	59	0.4	0.87
FRCFSSP03	72	0.3	0.74
FRCFSSP04	79.5	0.2	0.72
FRCFSSP05	70	1.0	2.5
FRCFSSP06	73	0.2	0.52
FRCFSSP07	29.5	0.2	0.20
FRCFSSP08	40	0.2	0.33
FRCFSSP09	36	0.6	0.74
FRCFSSP10	72	1.1	2.8

Note:

^a Unit volume is calculated as the sediment volume per unit length.

Table 4. Estimated Sediment Volumes

Upstream Transect	Downstream Transect	Location	Segment Length ^a (ft)	Volume (yd ³)	2007 Volume (yd ³)
BRFSSP01	BRFSSP02	Big River at Bone Hole	30	297	
BRFSSP02	BRFSSP03	Big River at Bone Hole	26	250	
		Total for Big River at Bone Hole:	56	547	
SFSP01	SFSP04	Big River at St. Francois State Park	1,697	20,558	
SFSP02	SFSP01	Big River at St. Francois State Park	97	1,136	
SFSP03	SFSP02	Big River at St. Francois State Park	103	803	
		Total for Big River at St. Francois State Park:	1,897	22,497	
OCFSSP01	OCFSSP02	Owl Creek	440	298	
OCFSSP02	OCFSSP03	Owl Creek	495	908	
		Total for lower Owl Creek:	935	1,206	3,650^b
FRCFSSP01	FRCFSSP02	Flat River Creek	1,986	1,783	
FRCFSSP02	FRCFSSP03	Flat River Creek	1,256	1,032	
FRCFSSP03	FRCFSSP04	Flat River Creek	1,564	1,147	
FRCFSSP04	FRCFSSP05	Flat River Creek	1,664	2,764	
FRCFSSP05	FRCFSSP06	Flat River Creek	2,868	4,351	
FRCFSSP06	FRCFSSP07	Flat River Creek	3,721	1,339	
FRCFSSP07	FRCFSSP08	Flat River Creek	1,622	431	
FRCFSSP08	FRCFSSP09	Flat River Creek	7,354	4,021	
FRCFSSP09	FRCFSSP10	Flat River Creek	2,439	3,943	
		Total for lower Flat River Creek:	24,474	20,811	13,385^c

Notes:

^a Segment length was measured along river or creek centerline in ArcGIS using NAIP aerial photos (NAIP 2010).

^b The 2007 survey defined lower Owl Creek as the reach from the MR&BT railroad crossing to the Big River confluence (NewFields 2007). Surveyed stations were used as approximate midpoints for finding the volume of three segments in this reach. Applying this approach to the 2012 survey data, the sediment volume from the railroad crossing to the confluence of Owl Creek and Big River was approximately 1,660 yd³.

^c The 2007 survey defined lower Flat River Creek as the reach from river mile 5 to the Big River confluence (NewFields 2007). Gravel and sand bars were measured to make sediment volume estimates from station FR-4 (2012 station FRCFSSP01) to FR-7.5 (2012 station FRCFSSP09). The unit volume calculated from station FR-8 measurements (2012 station FRCFSSP10) were used to calculate the volume from station FR-7.5 to the Big River confluence.

ATTACHMENT A

**PHOTOS FROM 2012 SEDIMENT
PROBING SURVEY**

(FOUND ON ACCOMPANYING DISC)



Photo 1: Big River at Bone Hole transect BRFSSP01, right bank in foreground



Photo 2: Big River at Bone Hole transect BRFSSP02, facing the left bank



Photo 3: Big River at Bone Hole transect BRFSSP03, facing the left bank (low water crossing on right)



Photo 4: Big River at Bone Hole transect BRFSSP03, sediment



Photo 5: Big River at St. Francois State Park transect SFSP01, facing upstream



Photo 6: Big River at St. Francois State Park transect SFSP02, facing downstream



Photo 7: Big River at St. Francois State Park transect SFSP03, facing downstream



Photo 8: Big River at St. Francois State Park transect SFSP04, facing downstream



Photo 9: Owl Creek transect OCFSSP01, facing upstream and culvert of abandoned railroad bridge



Photo 10: Owl Creek transect OCFSSP01, facing downstream



Photo 11: Owl Creek transect OCFSSP02, facing downstream

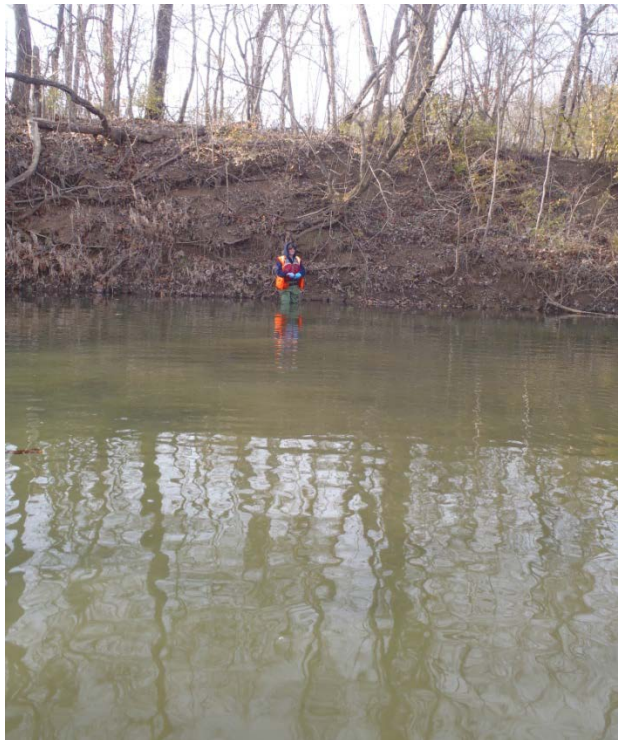


Photo 12: Owl Creek transect OCFSSP03, facing left bank



Photo 13: Flat River Creek transect FRCFSSP01, facing downstream



Photo 14: Flat River Creek transect FRCFSSP02, facing downstream



Photo 15: Flat River Creek transect FRCFSSP03, facing downstream



Photo 16: Flat River Creek transect FRCFSSP04, facing downstream and the right bank



Photo 17: Flat River Creek transect FRCFSSP05, facing downstream



Photo 18: Flat River Creek transect FRCFSSP06, facing left bank, gravel bar in foreground



Photo 19: Flat River Creek transect FRCFSSP07, facing downstream



Photo 20: Flat River Creek transect FRCFSSP08, facing downstream



Photo 21: Flat River Creek transect FRCFSSP09, facing downstream



Photo 22: Flat River Creek transect FRCFSSP10, facing the left bank

ATTACHMENT B

FIELD FORMS FROM 2012
SEDIMENT PROBING SURVEY

(FOUND ON ACCOMPANYING DISC)

Sediment Probing Section Form

Sample Location: BRESSPO1

Date: 11/29/12 Samplers: SD, BL, JS

Longitude: Right bank: 37.8704898°N
Left bank: 37.87542132°N

Latitude: Right bank: 90.55073564°W
Left bank: 90.55066541°W

Bank Width (m) 149ft

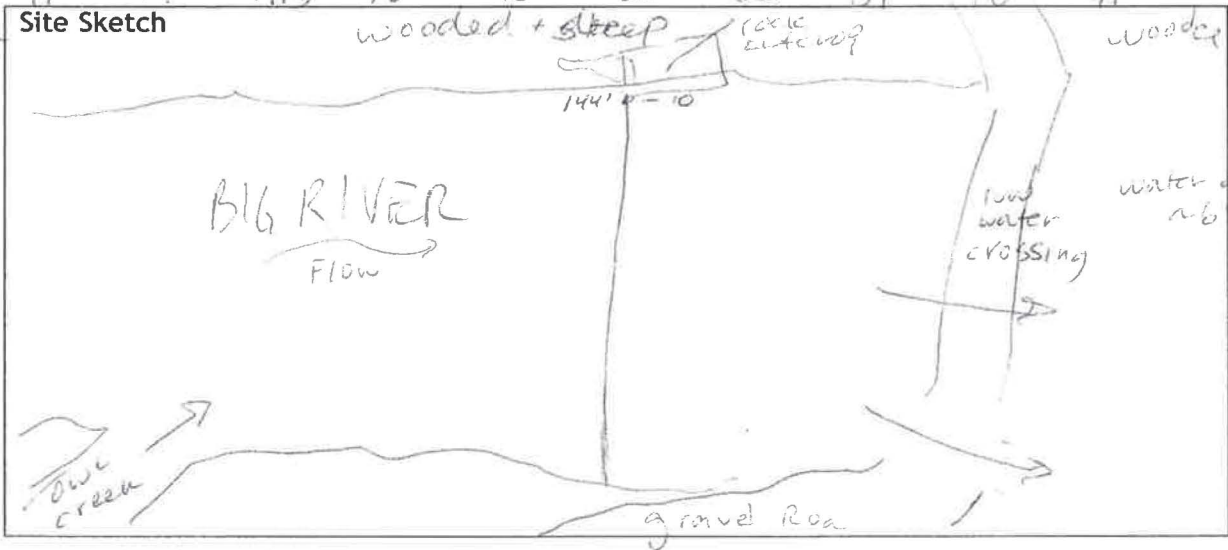
Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

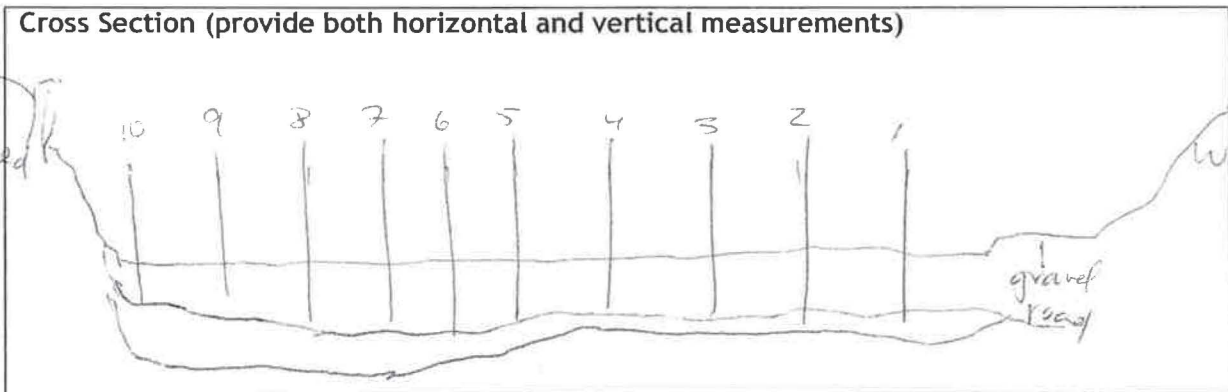
SD:	17"	4"	5"	10"	23"	20"	38"	36"	40"	40+
WD:	41"	47"	49.5"	48"	43"	38"	35"	39"	40"	41"

SD = sediment depth
WD = water depth

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

35 - white board

36 - sediment probing

37 - sediment probing

38 - sediment probe at 10th station on transect

① sandy gravel

⑥ sandy gravel

② "

⑦ sandy gravelly

③ "

⑧ "

④ "

⑨ "

⑤ "

⑩ soft silty clay

sandy gravel/
gravelly sand

water video 15 min

Sediment Probing Section Form

Sample Location: BRESC002

Date: 11/29/12 Samplers: SiD, BL, SS

Longitude: Left Bank: 37.84544724°N
Right Bank: 37.87506476°N

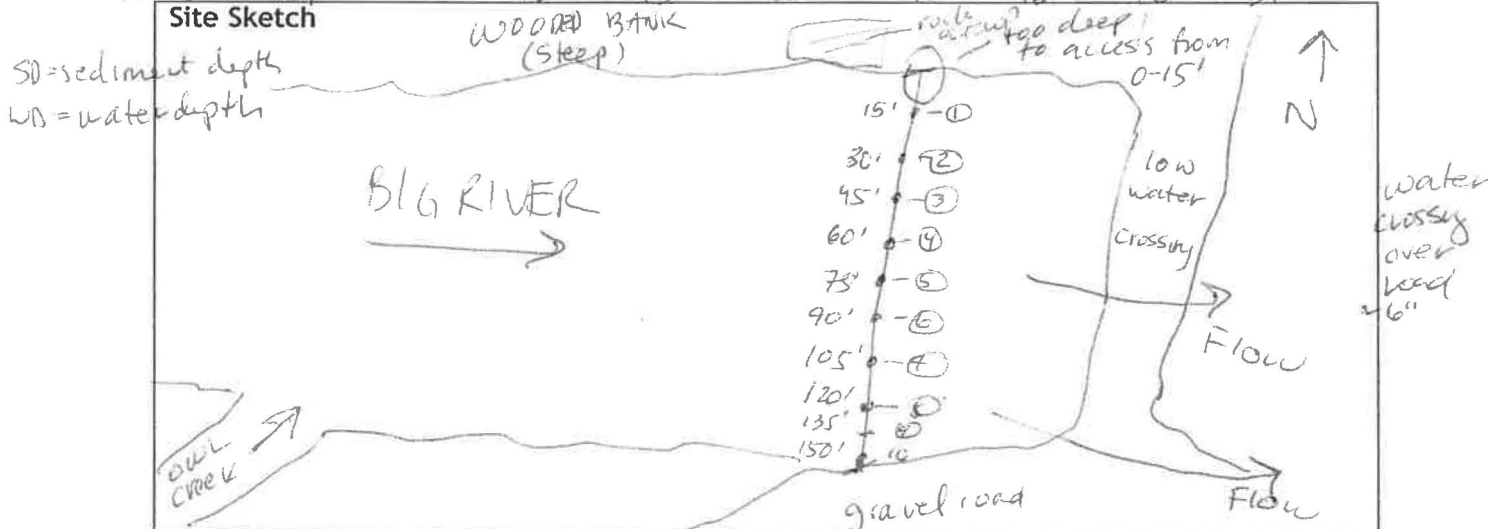
Latitude: Left Bank: 90.55049475°W
Right Bank: 90.55049141°W

Bank Width (m) 152ft

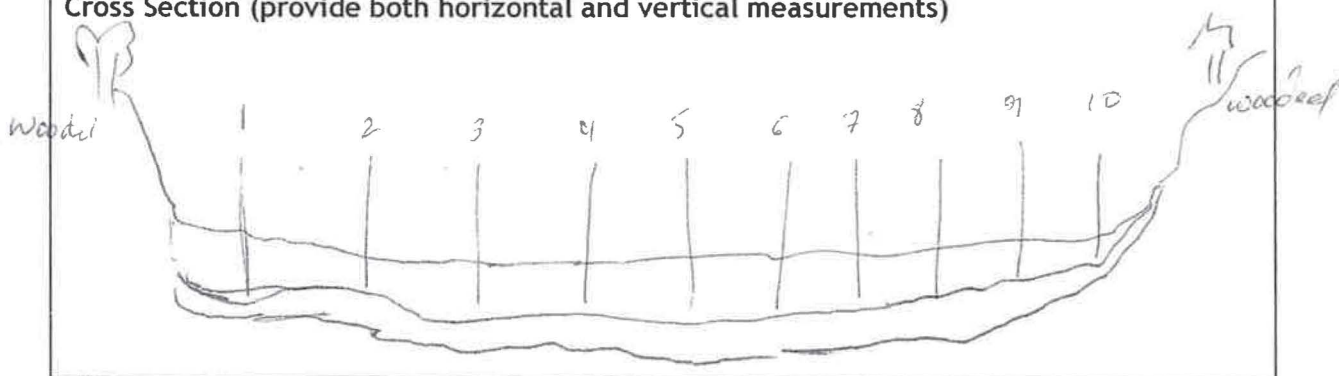
Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

SD = 30"	31"	32"	26"	16"	144"	26"	15"	10"	3"
WD = 45"	39"	36"	40"	43"	43"	43"	42"	40"	31"



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

31- white beard
32- looking US w stream width mens
33- looking at sedim probing

- | | |
|----------------|----------------|
| ① sandy gravel | ④ sandy gravel |
| ② sandy gravel | ⑤ sandy gravel |
| ③ sandy gravel | ⑥ sandy gravel |
| ④ sandy gravel | ⑦ sandy gravel |
| ⑤ sandy gravel | ⑧ sandy gravel |
| ⑥ sandy gravel | ⑨ sandy gravel |
| | ⑩ sandy gravel |

Sediment Probing Section Form

Sample Location: BRFSSP03
 Longitude: Left Bank: 37.87551467° N
Right Bank: 37.87506157° N
 Bank Width (m): 173.0 ft

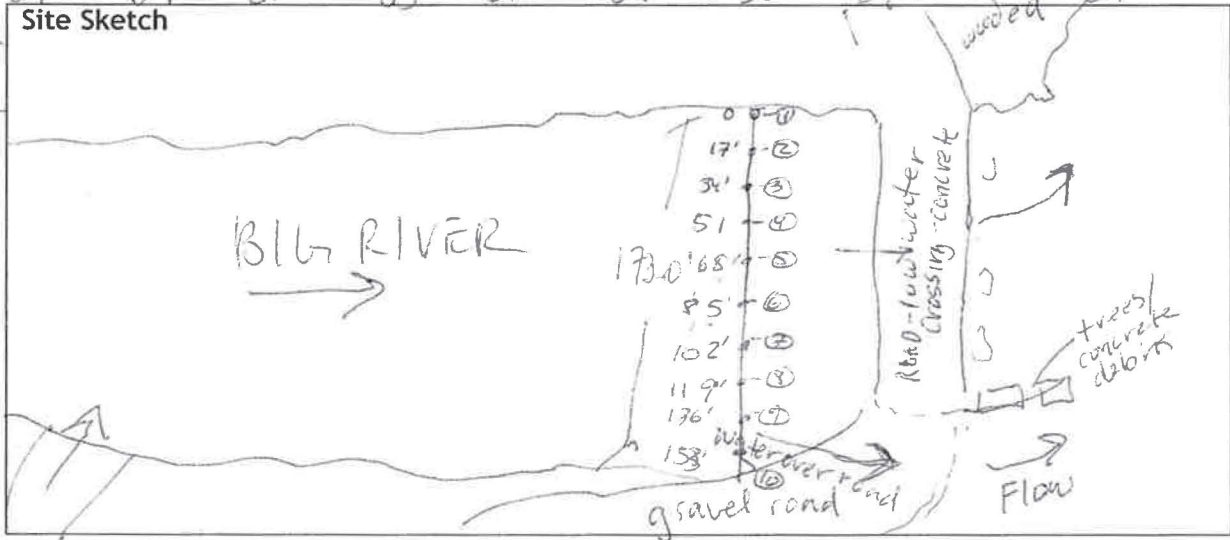
Date: 11/29/12 Samplers: SW, BL, TS
 Latitude: Left Bank: 90.55033414° W
Right Bank: 90.55060373° W
 Number of Sediment Depth Estimates: _____

Sediment Depths: (5 to 10 measurements)

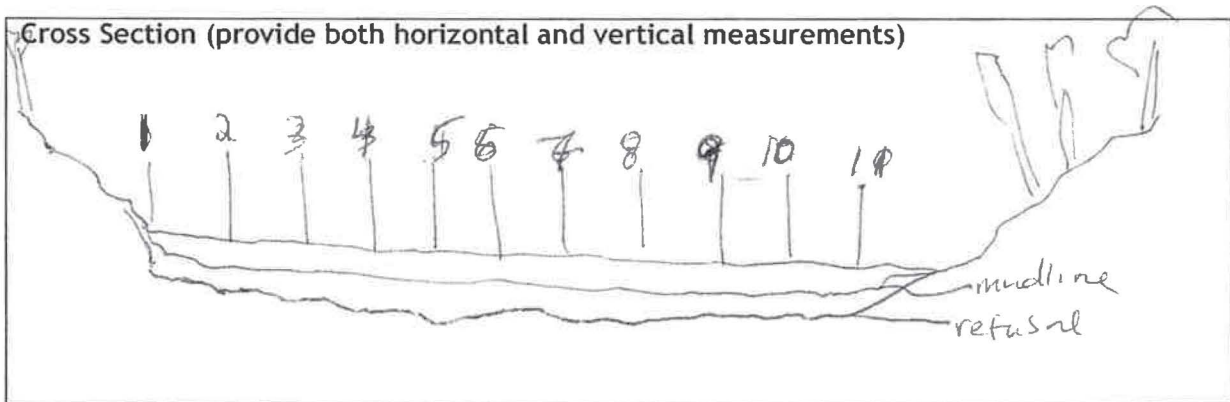
SD: 29" 16" 22" 29" 14" 19" 17" 18" 22" 5"
 WD: 29" 29" 31" 35" 37" 34" 36" 34" 33" 24"

Site Sketch

SD = sediment depth
 WD = water depth



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

24 - whiteboard
 25 - probing location 03
 26 - measuring distance to transect location
 27 - measuring WD/SD
 28 - measuring WD/SD
 29 - looking down at sediment surf.
 30 - looking down at sediment surf.

- ① - sandy gravel st
- ② - sandy gravel sec
- ③ surface - sandy gravel
- ④ surface - gravel/cobble
- ⑤ st - gravel
- ⑥ sandy gravel
- ⑦ sandy gravel
- ⑧ sandy gravel
- ⑨ sandy gravel
- ⑩ sandy gravel ss 11/29/12
cobble/gravel

Sediment Probing Section Form

Sample Location: OLCSSP01

Date: 11/29/12 Samplers: B40.5W TS

Longitude: 37.87229187 N

Latitude: 90.55223827 W

Bank Width (m) 40 ft

Number of Sediment Depth Estimates: 11

Sediment Depths: (5 to 10 measurements)

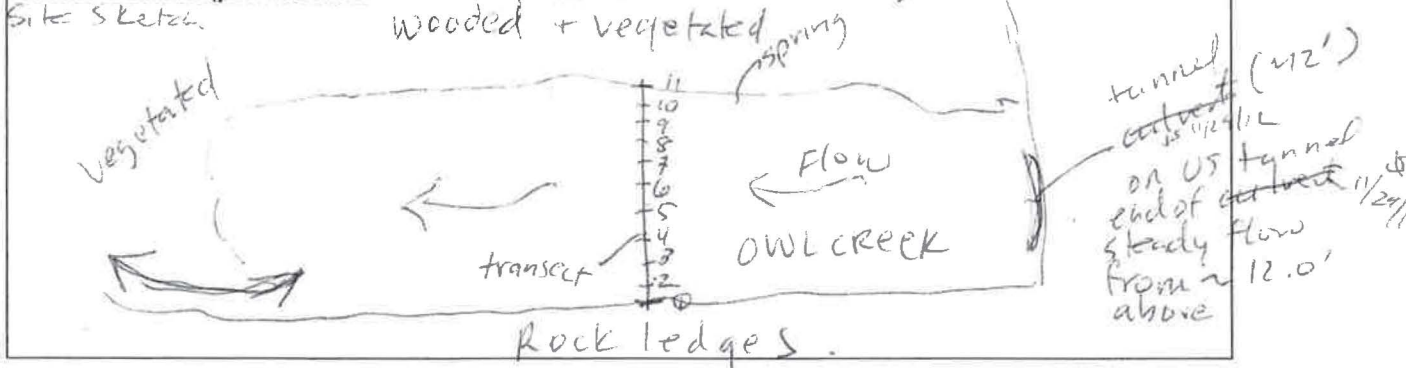
	8'	12'	16'	20'	24'	28'	32'	36'	40'
SD =	0.0"	0.0"	0.0"	0.0"	0.0"	0.0"	0.75'	1.5"	5.0
WD =	5.0"	6.5"	7.0"	10.75"	12.25"	12"	13"	12.5"	10"

Site Sketch Cross-section



Gross-Section (provide both horizontal and vertical measurements)

Site Sketch



Notes (Photo Number and substrate description):

Coords taken @ center of transect

light algae, w/ light silt layer on bedrock surface

46 - looking US @ location

49 - looking @ tunnel

47 - looking LB to RB along transect

50 - Whiteboard

48 - looking DS @ location

① bedrock

⑧ - cobble, silty sand

② "

⑨ "

③ "

⑩ silty sand, cobble

④-⑦ bedrock

⑪ silt

Sediment Probing Section Form

Sample Location: OCFSSP02

Date: 11/29/12 Samplers: SW, BL, JS

Longitude: 37.87345561 N

Latitude: 90.55191180 W

Bank Width (m) 38.0 ft

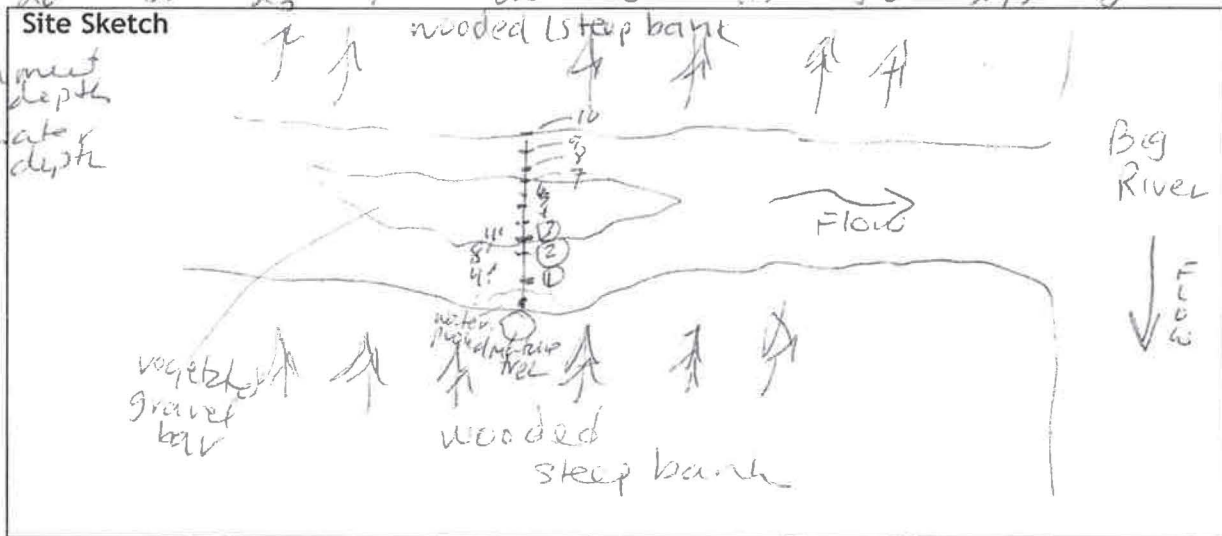
Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

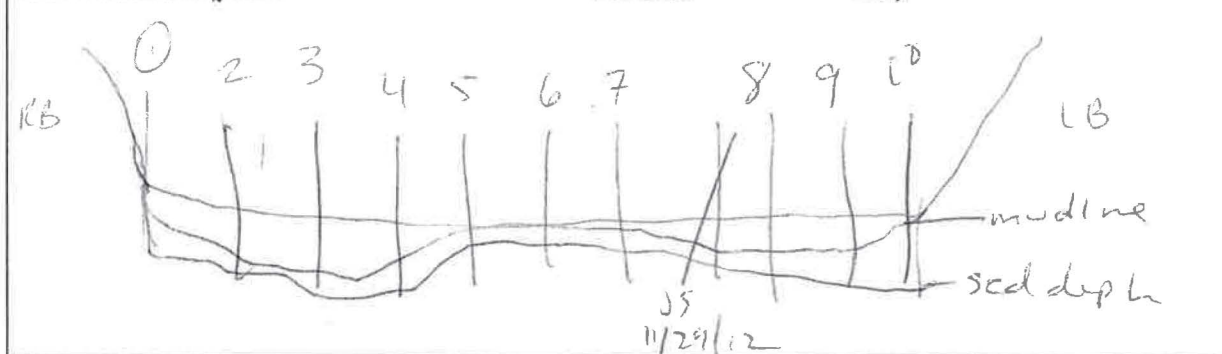
	1'	8'	11.0'	15'						
SD =	Sediment Depths: (5 to 10 measurements)					21"	24"	28"	34"	37.5"
	20"	14.5"	2.5"	14.5"	11.5"	5"	3.0"	7.0"	9.25"	17"
WD =	20"	30"	23"	7.0"	0.5"	0"	4.5"	5.0"	5.75"	3"

Site Sketch

SD = sediment depth
WD = water depth



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

- Coordinates taken at middle of transect
- meas collected every 4.0'
- 42 - looking US at location
- 43 - looking from LB to RB at location
- 44 - looking DS at location
- 45 - whiteboard

- ① - silty w/ leaf litter
- ② - silty sand, gravel
- ③ - coarse gravel w/ cobble - hard
- ④ - sandy silt, leaf litter

- ⑤ sandy silt
- ⑥ silt w/ gravel
- ⑦ silt/sand on cobble, leaf litter

Sediment Probing Section Form

Sample Location: OCFSSP03

Date: 11/29/12 Samplers: SW BL JS

Longitude: 37.87465750°N

Latitude: 90.55118395°W

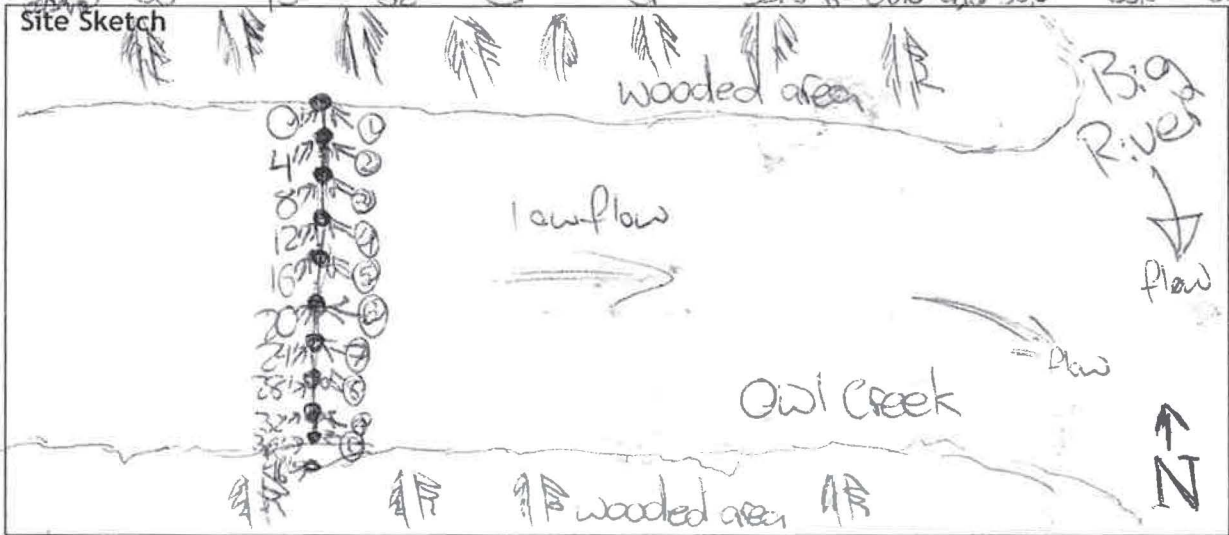
Bank Width (m) 46ft

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

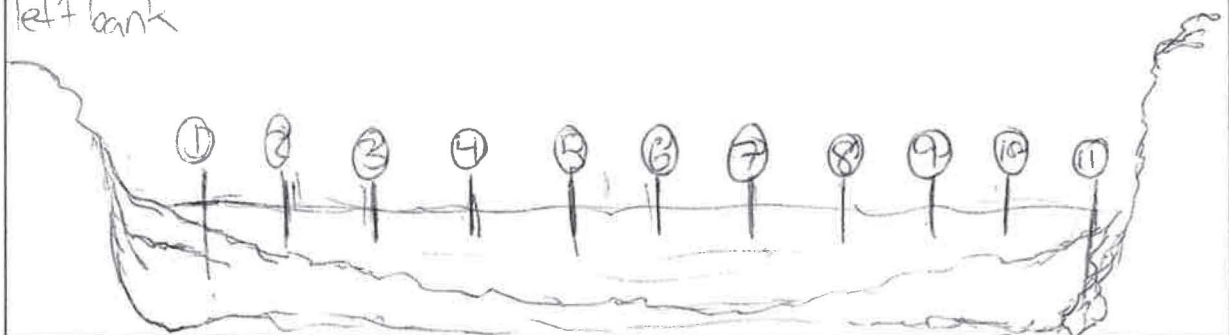
SD: 49" 18.5" 170" 9.0" 10.5" 110" 6.5" 40" 4.0" 8.0" 59.0"
WD: 44.5" 35" 42" 32" 3" 31" 33.5" 28.0" 35" 80" 35.0" 3.5"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)

left bank



Notes (Photo Number and substrate description):

Coordinate coordinate in middle of transect
40 - Jane Sand standing on right bank.
41 - Jane Sand mid channel

① clay, hard, soft at the top.
② clay
③ clay
④ light sandy gravel

⑤ sandy gravel
⑥ loose sandy gravel
⑦ sandy gravel
⑧ sandy gravel
ae.

⑨ couple inches soft silt on top of sandy gravel

Sediment Probing Section Form

Sample Location: FRCFSSP01

Date: 11/30/12 Samplers: SW, BL, JS

Longitude: 74° 51' 11" 37,836,01039° N

Latitude: 90.53068939° W

Bank Width (m): 74 ft

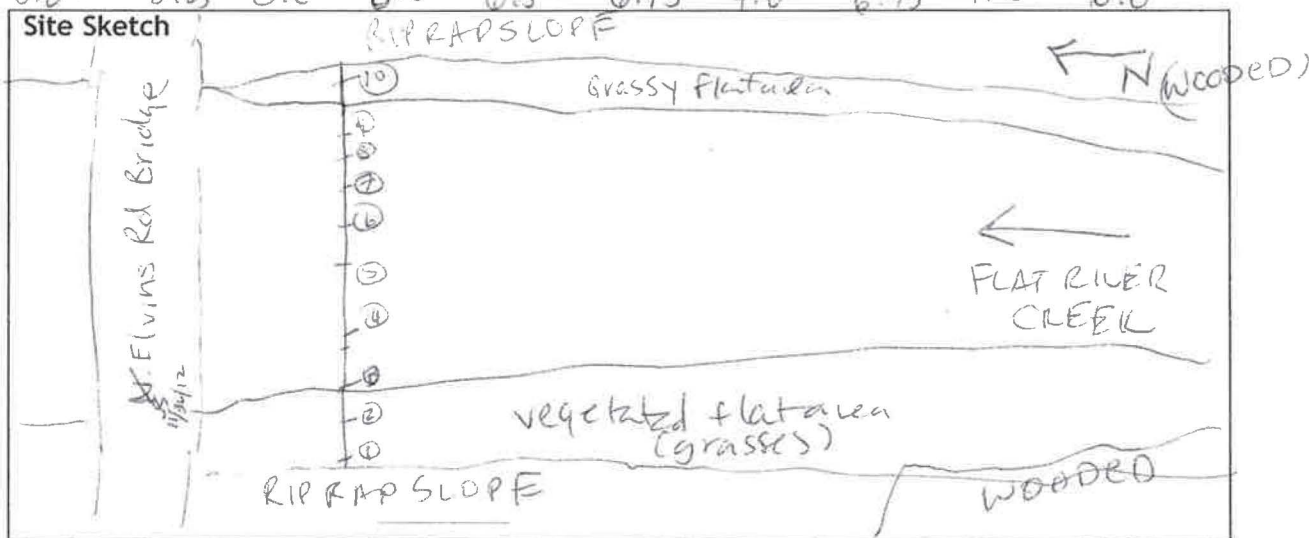
Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

39' 26' 53' 6' 74'

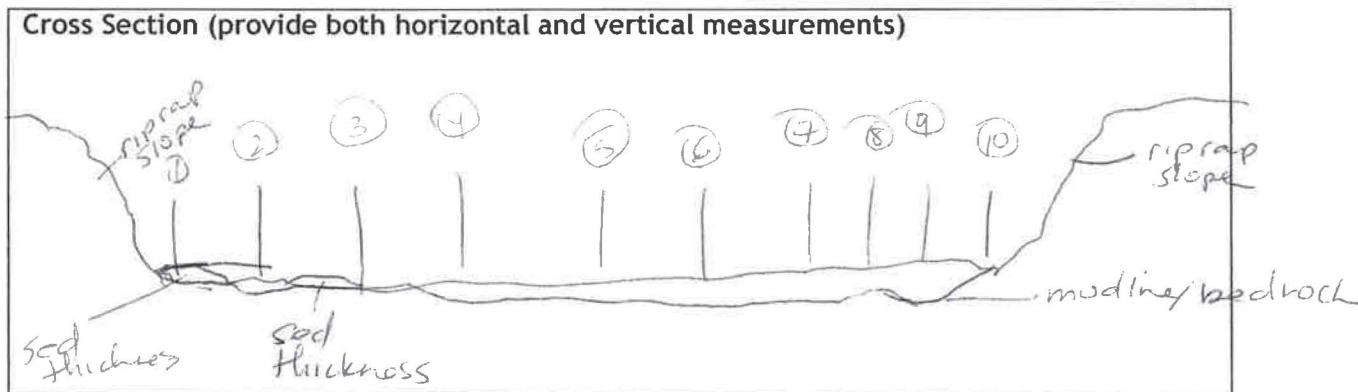
SD = 9.0" 7.0" 7.0" 6.0" 0.0" 0.0" 0.0" 0.0" 0.0" 10.5"
 CUD = 0.0" 0.25" 0.0" 6.0" 6.5" 6.75" 7.0" 6.75" 11.0" 10.0"

Site Sketch



*Drawing not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Corals collected from center of transect

85 - White barrel

88 looking US from under Bridge

86 - looking DS

87 - looking @ transect RB to LB

① grass w/ silt/sand

② silty loam w/ organics

③ "

④ ⑩ bed rock

Sediment Probing Section Form

Sample Location: FRCF-SP #2

Date: 11/30/12 Samplers: SW, BL, JS

Longitude: 37.83999176°N

Latitude: 90.52623824°W

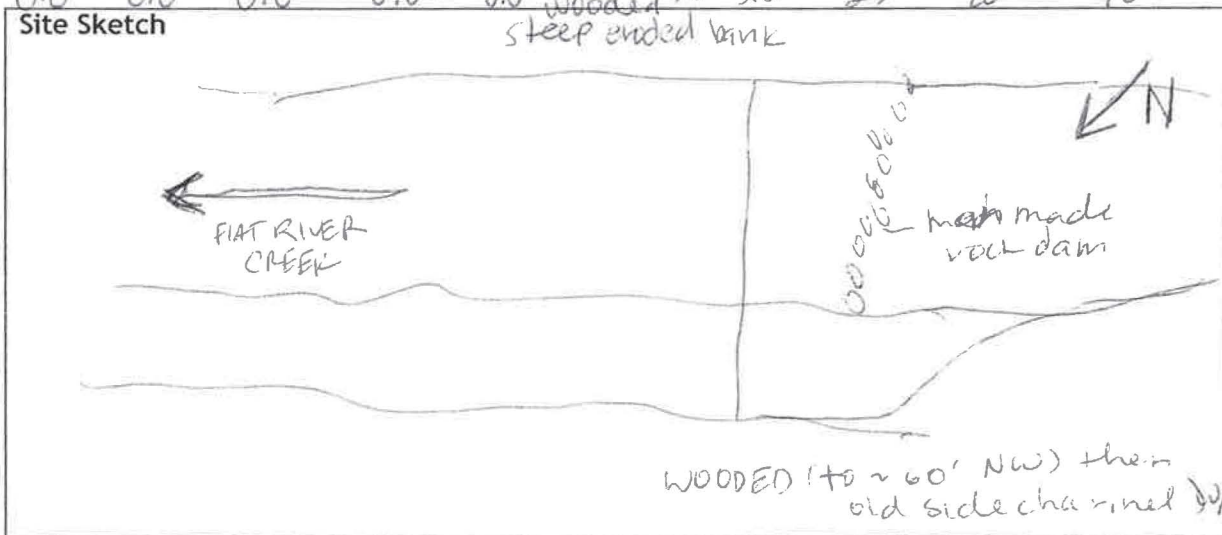
Bank Width (m): 57.0 ft

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

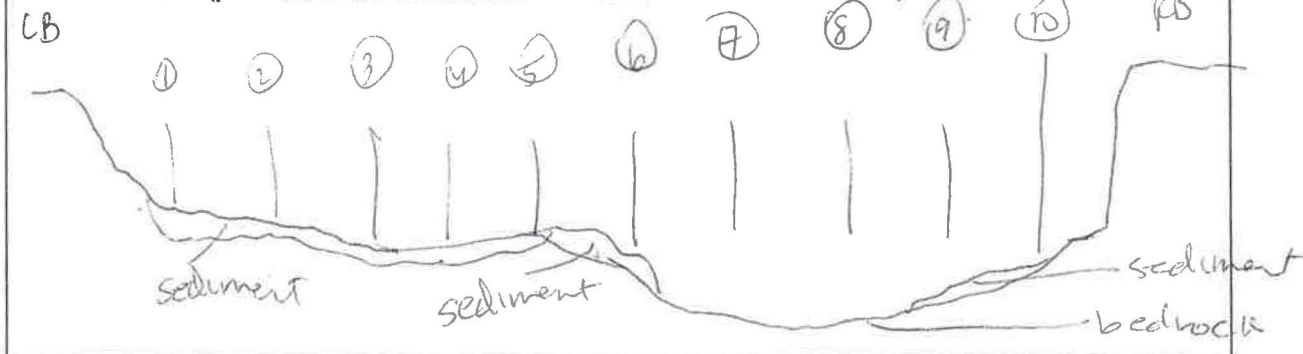
SD = 23" 3.5" 4.25" 2" 4.5" 4.25" 0.0" 0.0" 1.5" 5.0"
WD = 0.0' 0.0' 0.0' 0.0' 0.0' 30' 22" 23" 20" 10"

Site Sketch



* Drawings not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coord collected @ center of transect

89 - whiteboard

92 - 100mg DS

90 - LB to RB

91 - 100mg US

① sandy silt/organic

⑤ lg gravel/obble over sandy silt

② gravel/obble

⑥ sm gravel/sand

③ "

⑦ ⑧ bedrock

④ "

⑨ gravel/sand

Sediment Probing Section Form

Sample Location: FRCSSP03

Date: 11/30/12 Samplers: SW B L TS

Longitude: 37.84244069°N

Latitude: 90.52333747°W

Bank Width (m): 72.0 ft

Number of Sediment Depth Estimates: 10

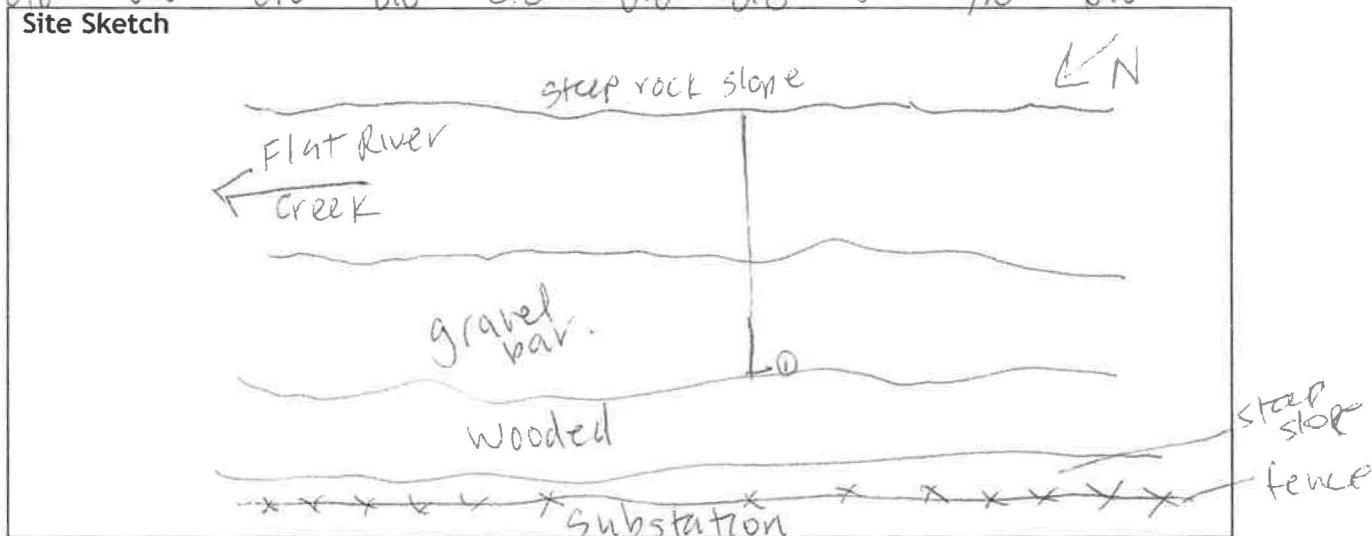
Sediment Depths: (5 to 10 measurements)

40 47 54 61 72.0'

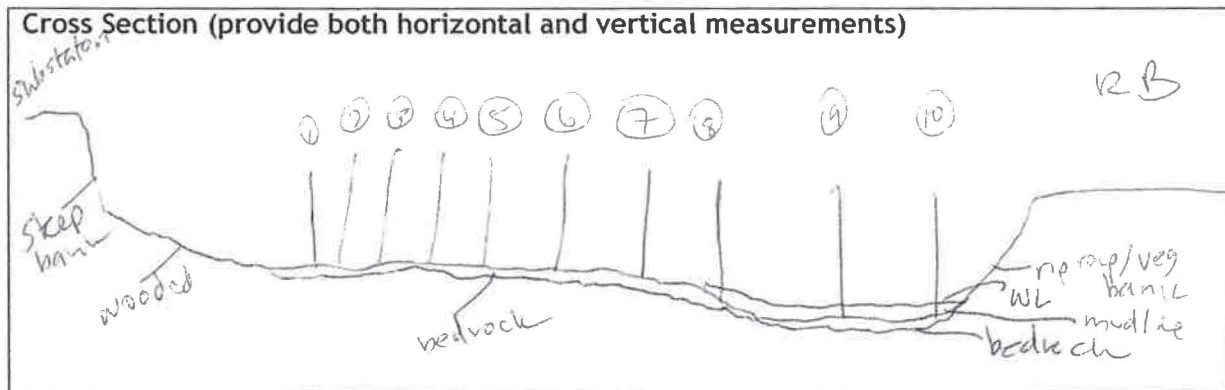
SD = 2.0" 3.0" 4.0" 2.5" 4.0"
WP = 0.0" 0.0" 0.0" 0.0" 0.0"

2.75" 3.0" 2.0" 5.0" 5.0"
0.0" 0.0" 0.5" 7.0" 6.0"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coords collected from center of gravel bar

93 - white board
94 - RB to LB along transect
95 - looking US
96 - looking DS
97 - looking DS at raised gravel bar

① organics
② silt + sm. gravel

③ "

④ gravel on sand

⑤ cobble/gravel sand

⑥ cobble/gravel sand

⑦ "

⑧ "

⑨ cobble, gravel, sand

⑩ sm. cobble, gravel sand

Sediment Probing Section Form

Sample Location: FLCFSSP04

Date: 11/30/12 Samplers: 4W, BL, JS

Longitude: 37.84540711 °N

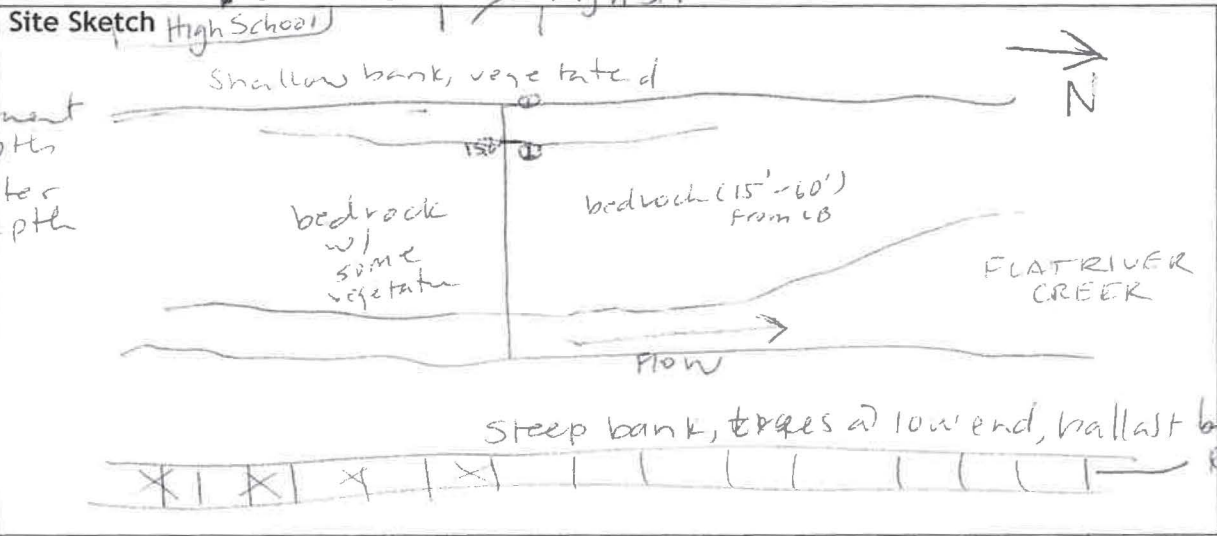
Latitude: 90.51966549 °W

Bank Width (m): 79.5 ft

Number of Sediment Depth Estimates: 5

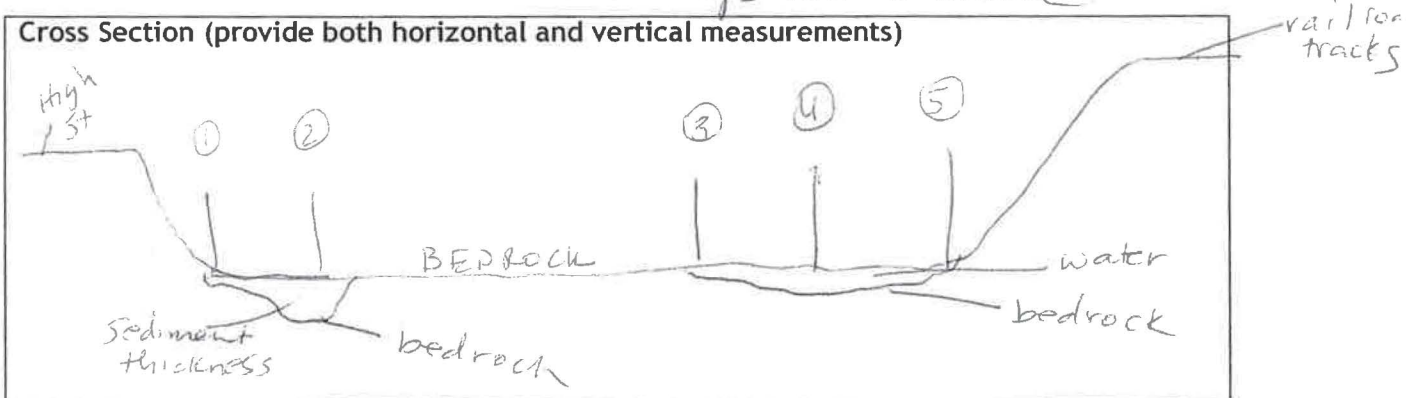
Sediment Depths: (5 to 10 measurements)

SD = 0.75" 14.5" 0.0' 0.0' 0.0' — — — — —
WD = 0.0" 0.0" 0.0" 7.5" 4" High St. — — — —



* Drawings not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description): JS 11/30/12

Coords collected @ center of transect left bank (target location)

- | | |
|---------------------------|--|
| 78 - Whitebroad | 81 - looky US of transect & bedrock pool |
| 79 - looky DS of transect | 82 - " " |
| 80 - " " | 83 - looky DS from bedrock pool |
| ① fine silt | 84 - looky RB to LB across transect |
| ② silt w/ veg sfc | |
| ③ bedrock | |
| ④ bedrock | |
| ⑤ bedrock | |

Sediment Probing Section Form

Sample Location: FRL FSSP 05

Date: 11/30/12 Samplers: SW, BL, TS

Longitude: 37.84920821° N

Latitude: 90.51713505° W

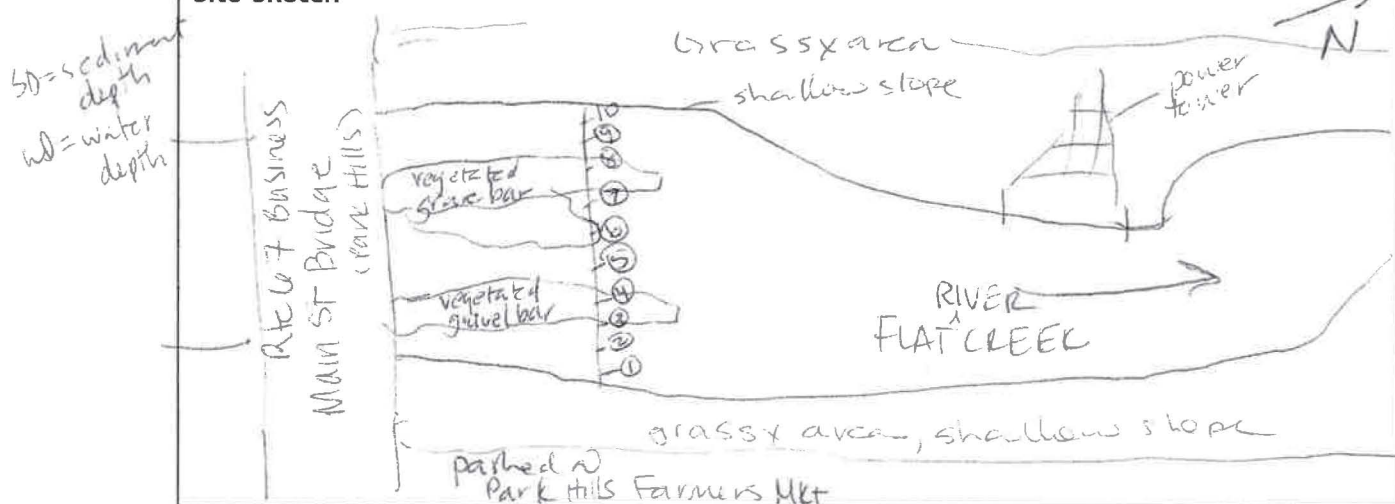
Bank Width (m) 70 ft

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

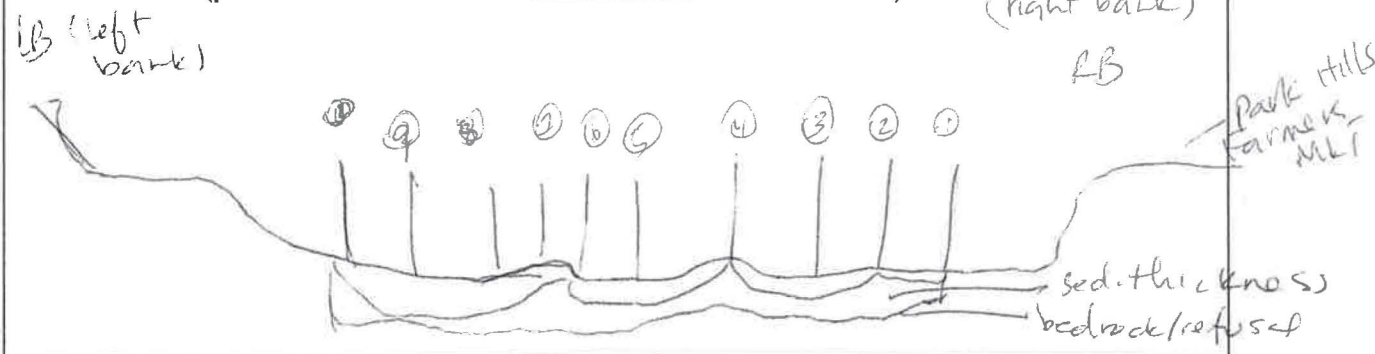
SD =	7.0"	26"	9.5"	18"	11.5"	29.5"	3"	0.5'	0.0"	9.5'
WD =	20"	0.0"	12"	0.0"	11"	0.0"	18"	24.5"	25"	11"

Site Sketch



* Drawings not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coords collected from center of transect.
 74 - white head
 75 - looking US RB 11/30/12
 76 - looking DS RB to LB
 77 - looking DS

- ① gravel + silt, grass on stc
- ② gravel (F) + sand, vegetz on stc
- ③ gravel + sand
- ④ bed rock
- ⑤ gravel, silt + sand
- ⑥ silty sand w/ vegetated stc + organics
- ⑦ sand, gravel on bedrock
- ⑧ gravel + silt on bedrock
- ⑨ rd sediment, bedrock
- ⑩ gravel w/ silt + sand

Sediment Probing Section Form

Sample Location: ERCFS SP 06

Date: 11/30/12 Samplers: BL, SL, JS

Longitude: 37.85540595° N

Latitude: 90.57241845° W

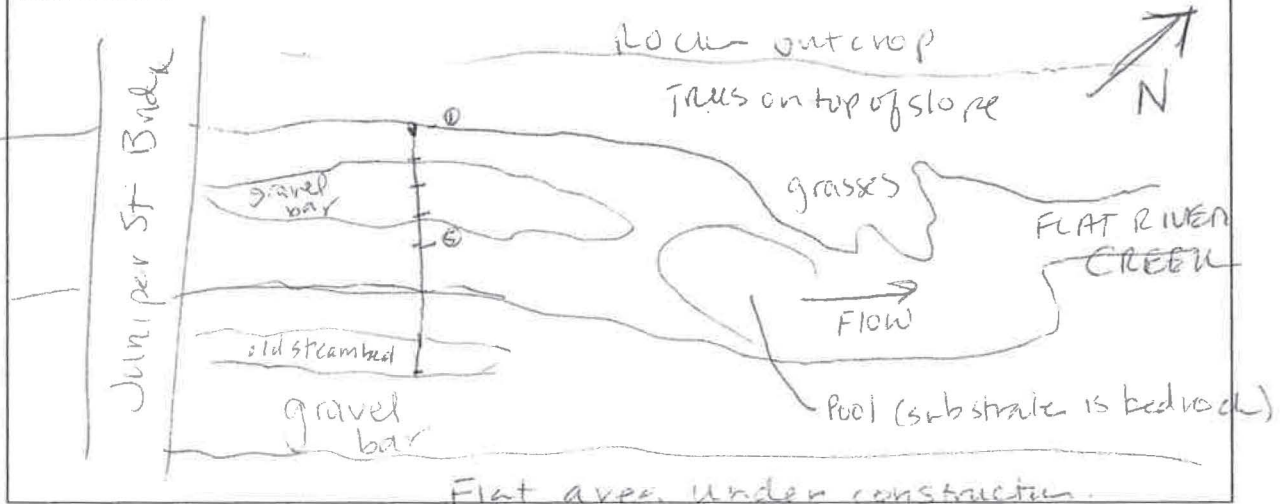
Bank Width (m): 73 ft

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

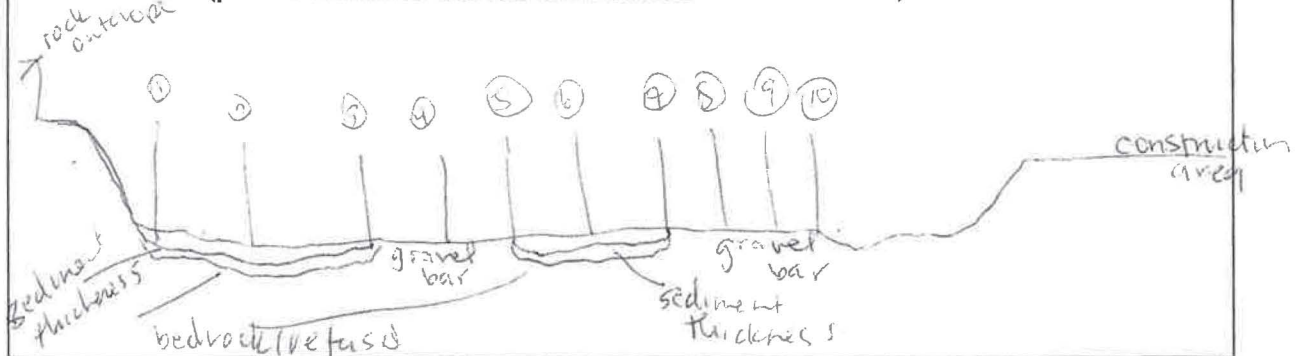
SD:	1"	1.5"	1.25"	2.0"	1.25"	3.0"	3.0"	2.0"	3.0"	5.0"
WD:	5"	3.0"	0.0"	0.0"	2.5"	3.5"	1.5"	0.0"	8.0"	0.0"

Site Sketch



* Drawings not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Words collected from center of transect
 68- whiteboard
 69- looking from RB to LB at transect
 70- looking DS at transect
 71- " US at transect
 72- looking at upper end of pool
 73- looking DS at pool

- ① cobble w/ silt
- ② "
- ③ gravel bar w/ organics + silt
- ④ "

- ⑥ 1y gravel, sm cobble, silty sand
- ⑦ sm cobble, silty silt in between
- ⑧ "
- ⑨ "
- ⑩ "

Sediment Probing Section Form

Sample Location: FRCPSSP 7

Date: 1/30/12 Samplers: SW, BL, JS

Longitude: 37.86300212° N

Latitude: 90.50410184° W

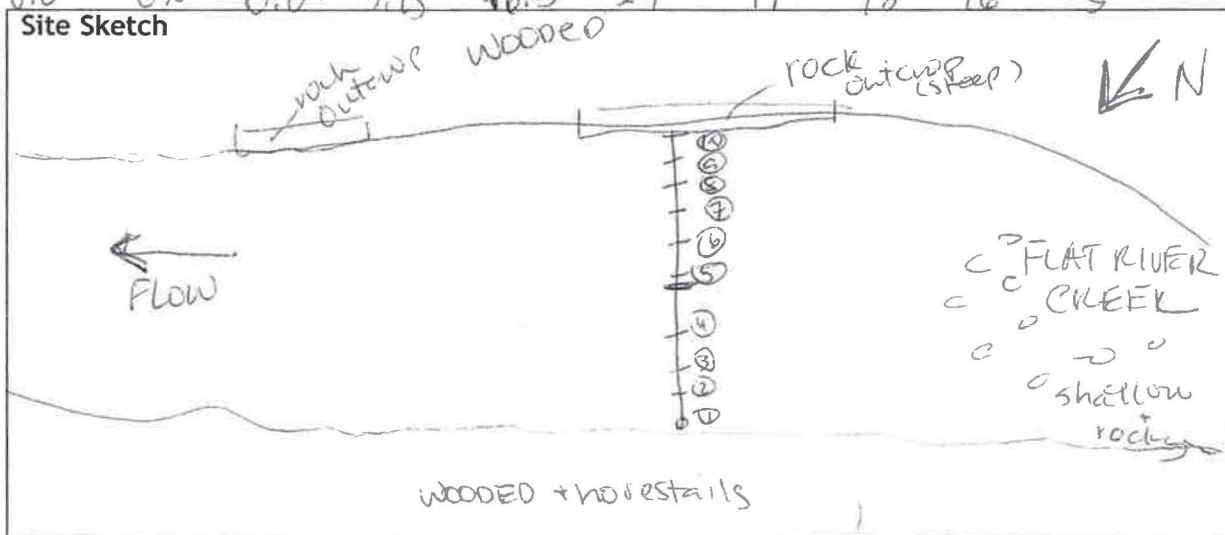
Bank Width (m): 29.5'

Number of Sediment Depth Estimates: 10

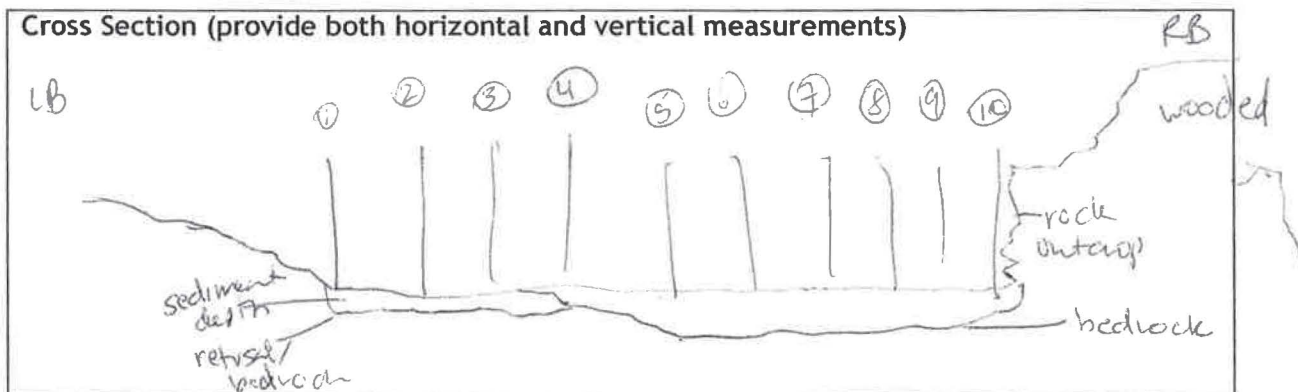
Sediment Depths: (5 to 10 measurements)

SD =	6.0"	4.0"	3.0"	5.0"	4.5"	0.0"	0.0"	0.0"	0.0"	0.0"
WD =	0.0"	0.0"	0.0"	5.25"	4.5"	27"	19"	18"	16"	5"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Cobbles collected in center of transect

① Sand, loess/gravel	64 - Whiteboard
② Sand + fine gravel	65 - looking US
③ Sand + fine gravel	66 - looking PS
④ gravel (coarse) + cobble sand	67 - Dragonfly
⑤ - ⑩ bedrock	

Sediment Probing Section Form

Sample Location: FRC FS SP Ø8

Date: 11/30/12 Samplers: SW, US, JS

Longitude: 37.86712668°N

Latitude: 90.50509747°W

Bank Width (m): 40 ft

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

24' 28' 30' 36' 40'

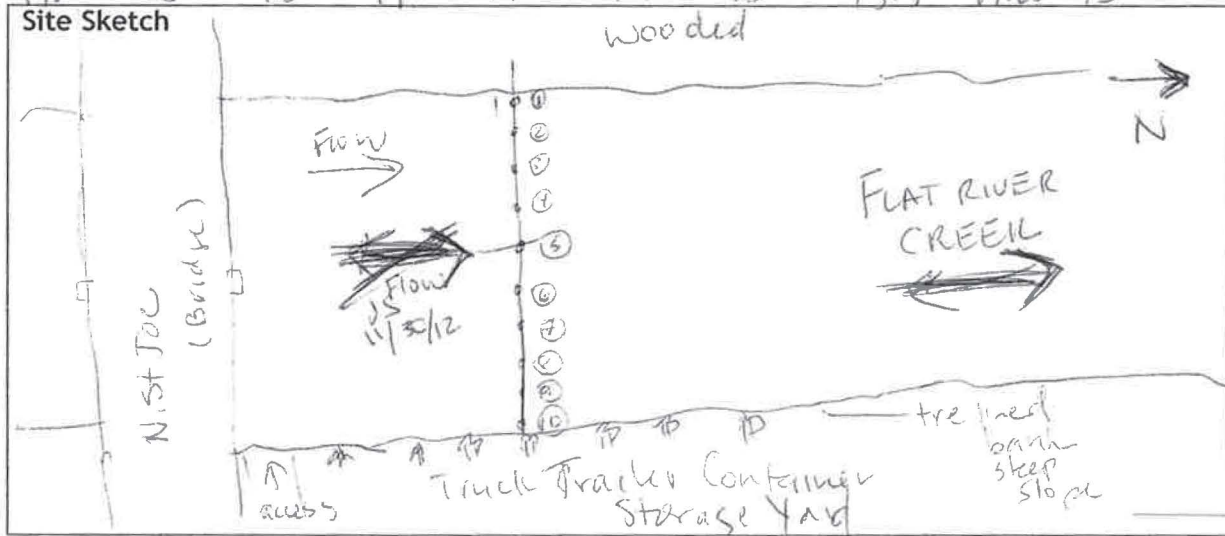
SD = 0.0" 0.0" 0.0" 0.0" 2.0"

5" 5" 6.5" 4.5" 4"

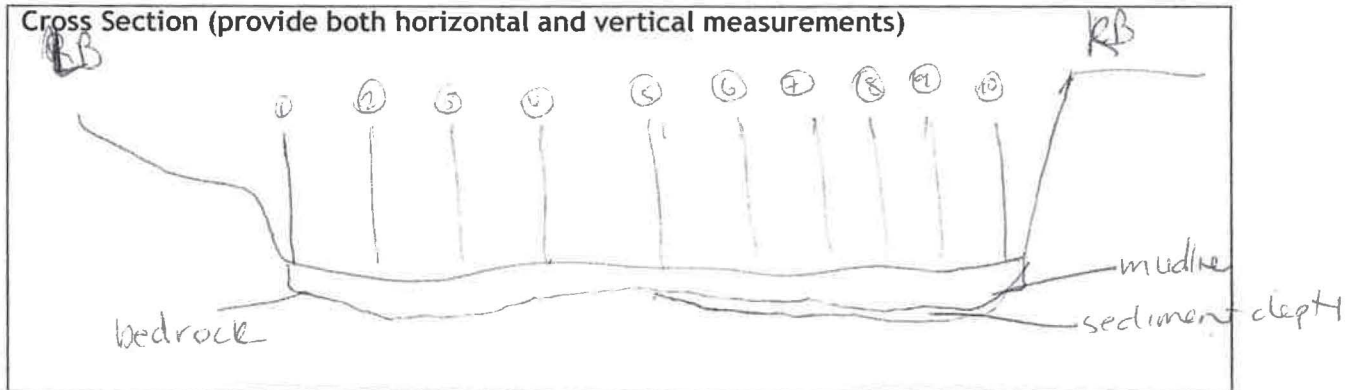
WD = 11.0" 18" 18" 19.1" 17"

14" 15" 15.5" 17.25" 15"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coords collected from center of transect
 61 looking DS @ location
 62 looking US from location
 63 white board

① bedrock

② "

③ "

⑤ fine silt on bedrock

⑦ silt on bedrock

② silt w/ gravel on bedrock

⑤ silt on bedrock

⑥ silty clay

⑩ clay on bedrock

Sediment Probing Section Form

Sample Location: FRCFSSPD9

Date: 11/30/12 Samplers: BL, SW, JS

Longitude: 34° 88' 26" 78 76' N

Latitude: 90.50306102' W

Bank Width (ft): 36.0 ft

Number of Sediment Depth Estimates: 10

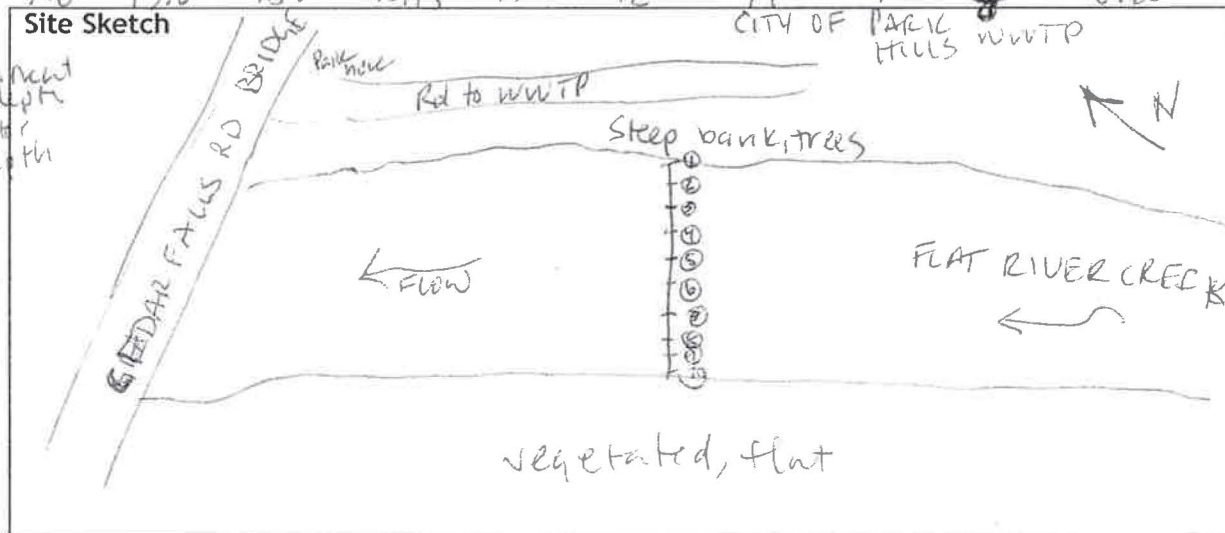
Sediment Depths: (5 to 10 measurements)

SD:	5.25"	5.5"	5.5"	8"	3.5"	4"	2.5"	8"	10"	14"
WD:	7.0"	13.0"	18.0"	15.75"	15"	12"	14"	10"	8"	0.25"

Site Sketch

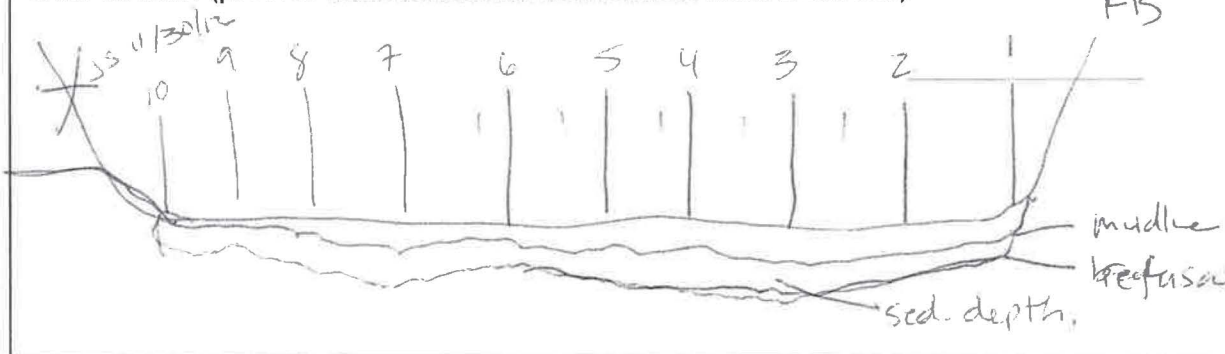
CITY OF PARK HILLS WWTP

SD: sediment depth
WD: water depth



* Drawings not to scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coords collected @ center of transect
US of transect fine sands in 3.0' pool, observed many fish
(mid channel to RB = bedrock, mid ch. to LB fine sand)
57 - whiteboard 59 - US
58 - PS 60 - looking across transect to NE

- ① cobble, gravel, sand + silt below
- ② boulders in area, sandy silt, large zone
- ③ "
- ④ boulders in area, metal, sandy gravel, under cobble
- ⑤ sandy gravel covered by cobble
- ⑥ sandy gravel
- ⑦ sandy gravel
- ⑧ sandy gravel, no cobble
- ⑨ sandy gravel, no cobble
- ⑩ " , leaf litter, no cobble

Sediment Probing Section Form

Sample Location: FRCFSSP10

Date: 11/30/12 Samplers: SW GL JS

08-18

Longitude: 37.88790867 N

Latitude: 90.49899460 W

Bank Width (ft) 72 ft

Number of Sediment Depth Estimates: 11

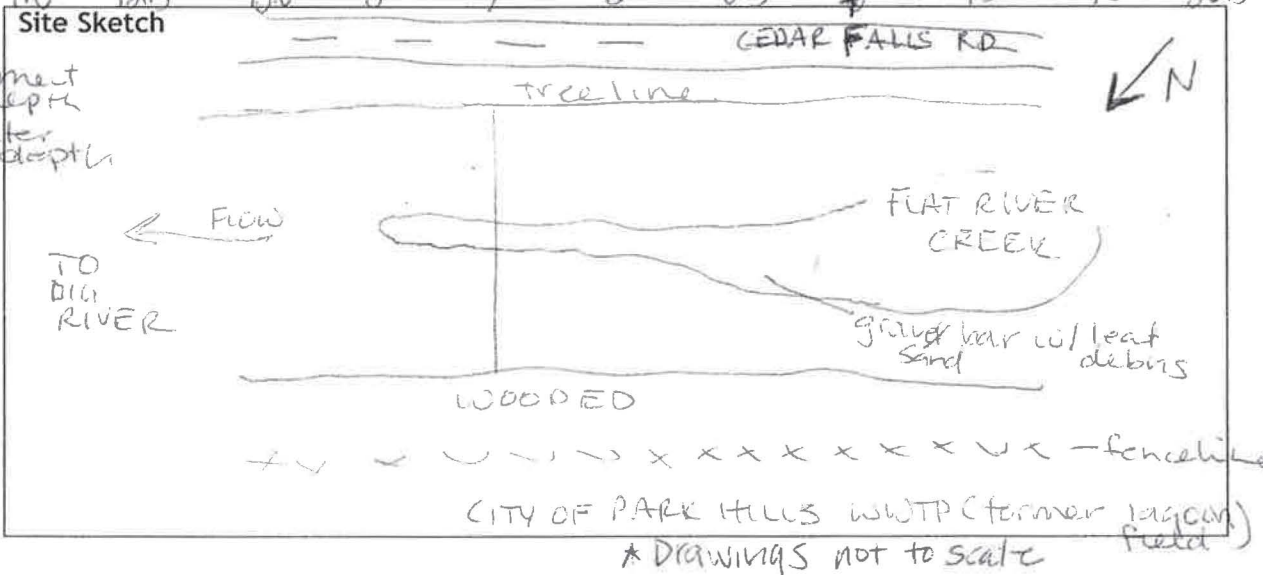
Sediment Depths: (5 to 10 measurements)

35' 45' 51' 58' 65' 72'

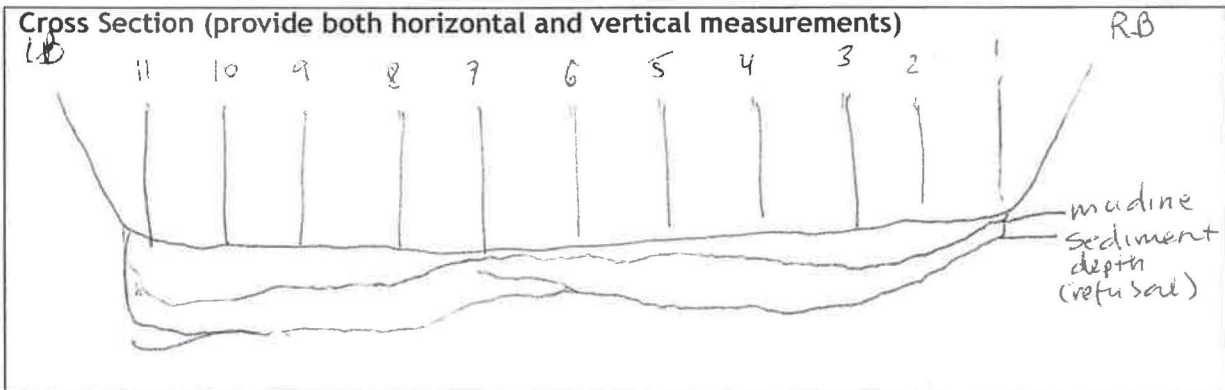
4.5" 5.0" 12.0" 17.5" 14" 1.0" 12.5" 13.0" 8" 7"

6" 25" 17" 16" 11" 8.5" 2" 0.5" 7" 15" 15" 20.5"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

Coords collected @ center of transect

S1 - white boater

S4 - looking @ probing

S2 - looking US

S5 - "

S3 - looking DS

S6 - "

① Silty sand w/ some clay + leaf litter

② Sand + silt on top w/ fine gravel below

③ Sandy gravel

④ " " " "

Sediment Probing Section Form

Sample Location: SFSP01 (St. Francis State Park) Date: 12/1/12 Samplers: JS, SW, BL

Longitude: 37.95462606°N

Latitude: 90.54023121°W

Bank Width (m) 113 FE

Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

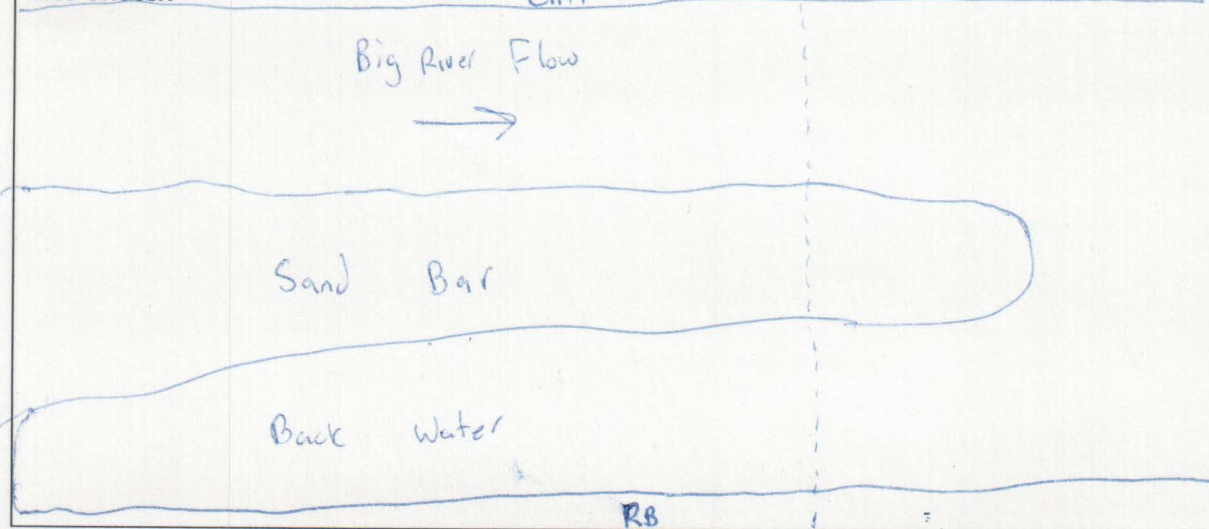
Taking measurements every 11 ft. Starting on RB 1 ft out

Inches
SSD
CWO

1'	12'	23'	34'	45'	56'	67'	78'	89'	0" → bedrock
57.5"	60"	>60"	>60"	>60"	56"	67"	78"	89"	0"
0"	7.5"	3.0"	0	4.0"	15.0"	24"	35"	43"	30"

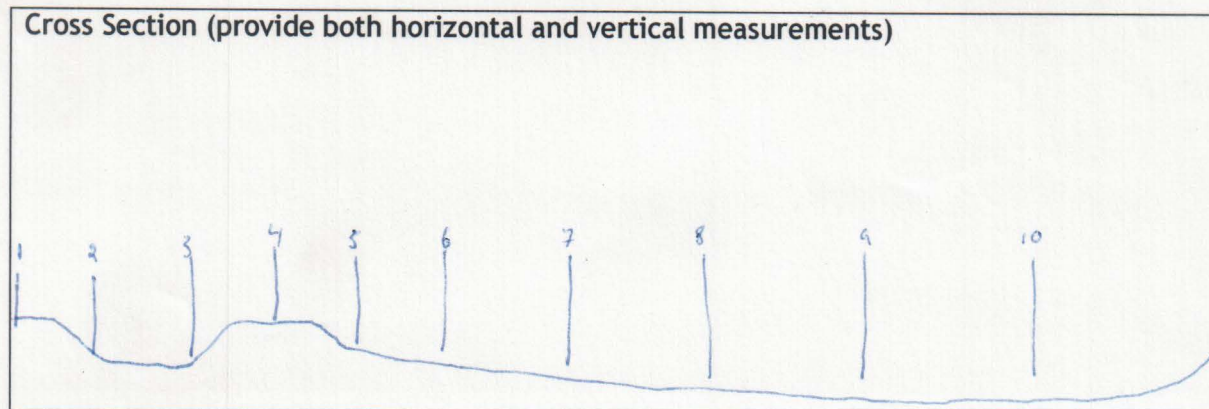
Site Sketch

Cliff



★ Map Not drawn to scale.

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

114	-	White beard	119	-	Looking D.S. at point bar and transect.
115	-	D.S. at transect			
116	-	D.S. at transect			
117	-	Looking Sediment piling			
118	-	D.S. Sediment piling			

Description of each probe

- 1) Rich Organic Clay on top, to sand
- 2) " " Same as above
- 3) Fine sand and gravel
- 4) Fine sand gravel
- 5) Same as above

- 6) Same as above
- 7) " "
- 8) " "
- 9) " "
- 10) Bedrock, boulders

Sediment Probing Section Form

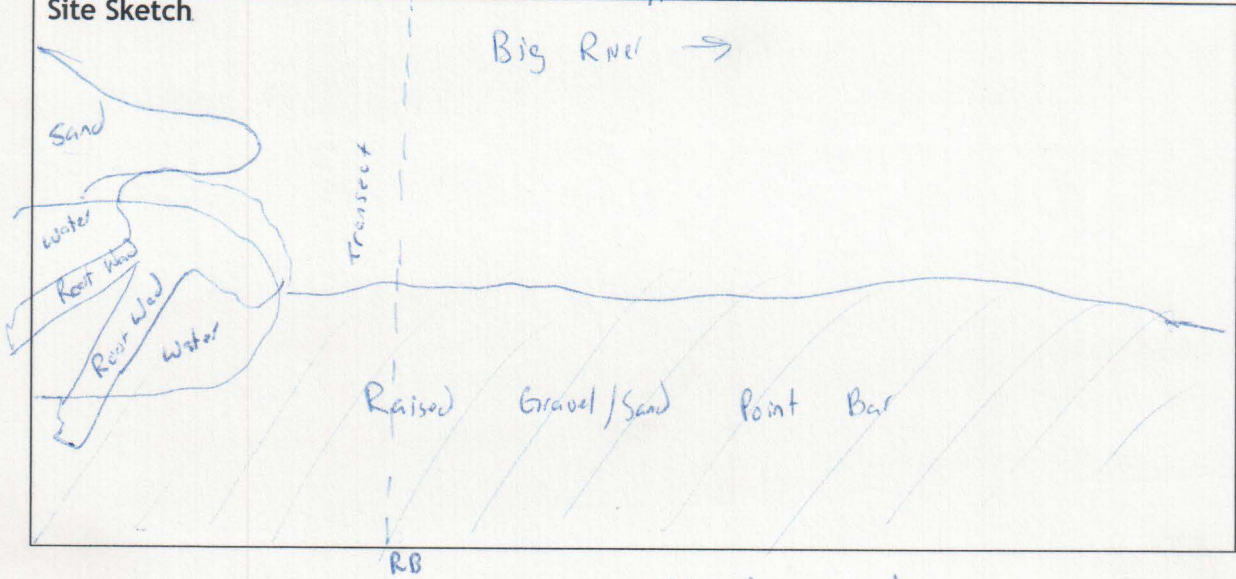
Sample Location: SFSP02 (St. Francis Park) Date: 12/1/12 Samplers: BL, JS, SW

Longitude: 37.95578412° N Latitude: 90.54104849° W

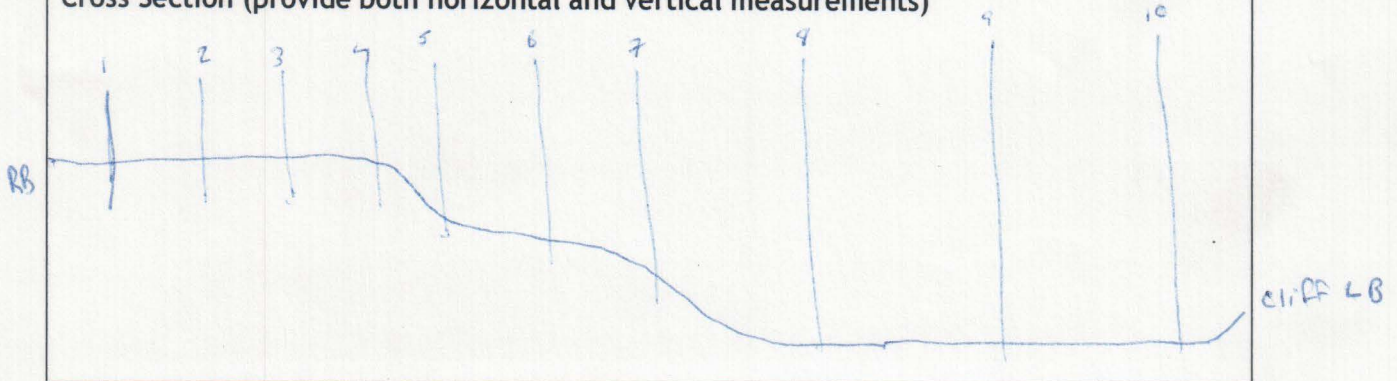
Bank Width (m) 108.5 ft Number of Sediment Depth Estimates: 10 Every 11 ft

From RB-LB	3 ft	14	25	36	47	58	69	80	91	102
Sediment Depths: (5 to 10 measurements)										
SD	17.5"	9.5"	760"	4.5"	48"	46"	43"	12"	0"	0"
WD	0"	0"	0"	0"	7"	11"	255" cliff	48"	45"	44"
									bedrock	bedrock

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

120-	white	board
121-	Looking	RB to LB at transect
122	--	--
123	D.S.	@ transect
124	U.S.	@ transect

- 1) Sand/Gravel
- 2) "
- 3) "
- 4) "
- 5) "
- 6) "
- 7) Fine Sand
- 8) " SW bedrock
- 9) " bedrock
- 10) bedrock

Sediment depth at 10 ft from RB = 11"
 -- -- 20 ft -- = 10"
 -- -- 30 ft -- = 40"

"Deep" sediment is between 28' + 29'
 40" - 60"

Sediment Probing Section Form

Sample Location: SFSP03 (St. Francois Park) Date: 12/1/12 Samplers: JS, SW, BL

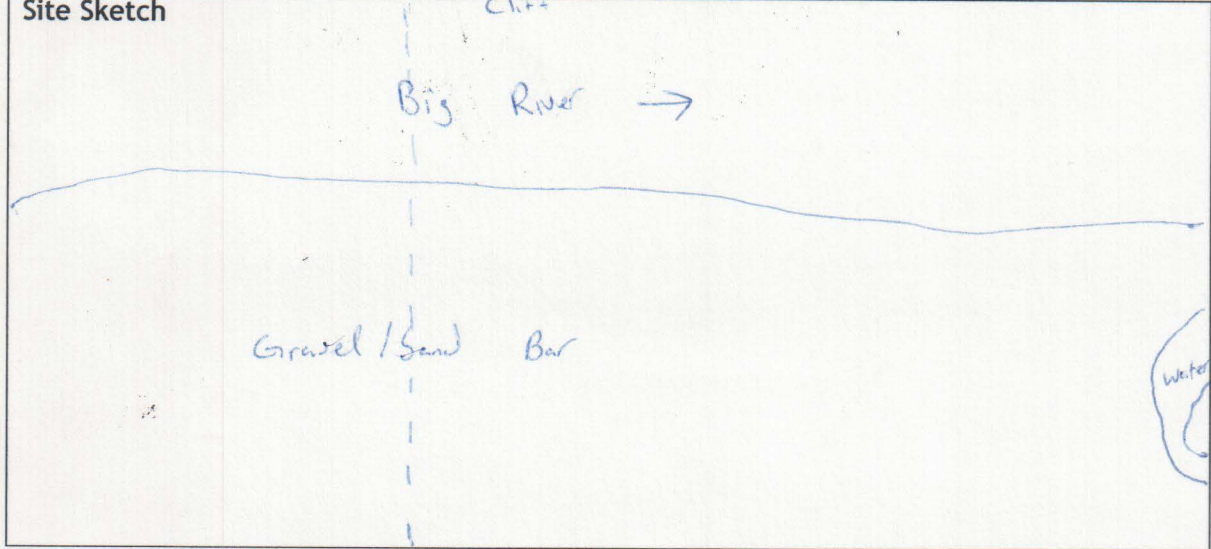
Longitude: 37.95432255°N Latitude: 90.53966347°W

Bank Width (m): 120.5 ft Number of Sediment Depth Estimates: 10

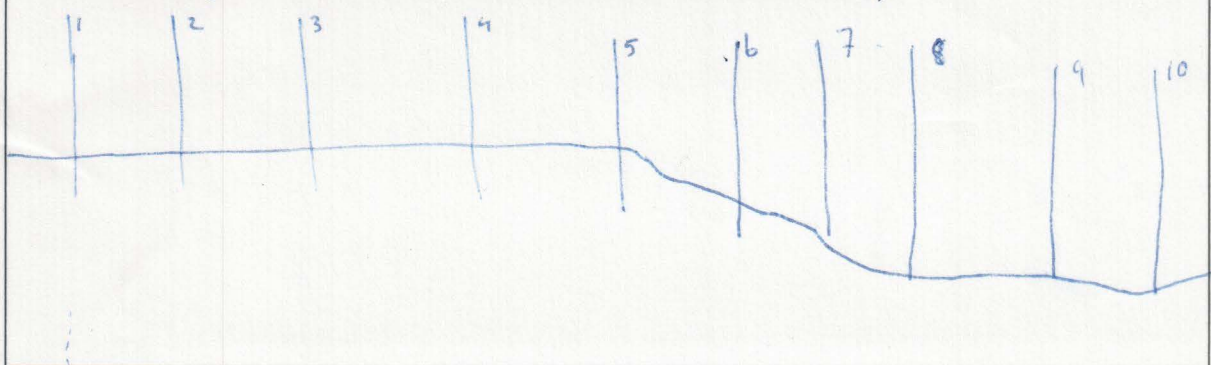
Sediment Depths: (5 to 10 measurements)

24" 8.5" 4.0" 6.0" 23" 41" 16" 11" 29" 38"
0" 0" 0" 0" 0" 5.5" LB 12.0" 23.0" 29.5" 27"

Site Sketch



Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

125	-	whiteboard
126	-	U.S. @ transect
127	-	D.S. @ transect
128	-	Looking at LB at transect
129	-	Looking at RB at transect

- 1) Fine gravel / sand
- 2) --
- 3) --
- 4) --
- 5) -- + few silt

- 6) same as above
- 7) Fine gravel / Sand / Silt
- 8) --
- 9)
- 10)

Sediment Probing Section Form

Sample Location: SFSP04 (St. Francis Park) Date: 12/1/2012 Samplers: B4, JS, SW

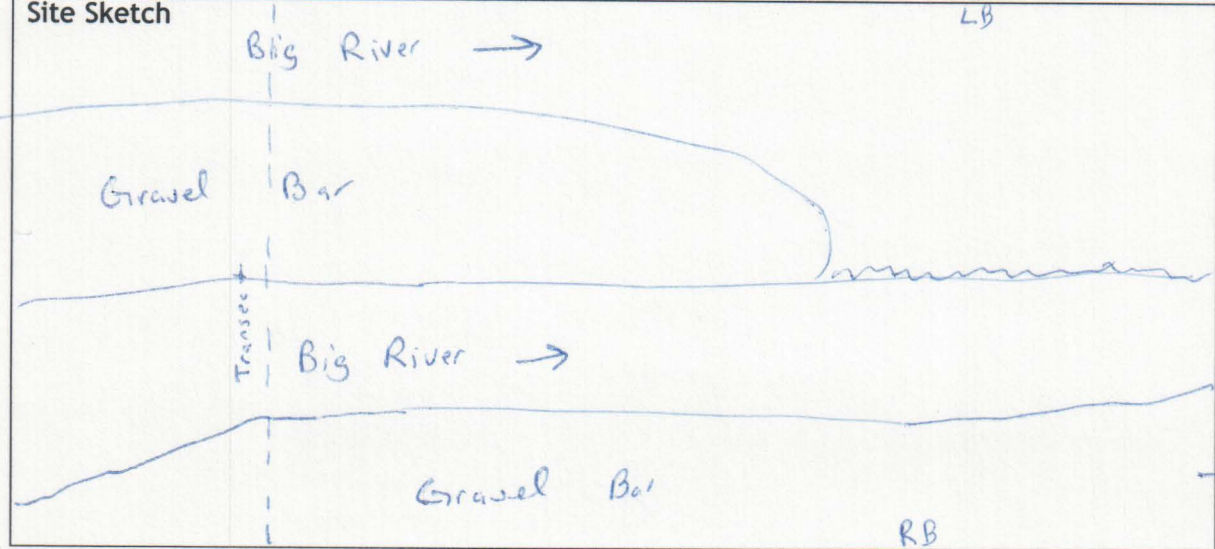
Longitude: 37.95872275 N° Latitude: 90.54121584 W°

Bank Width (m) 142.5 Fe Number of Sediment Depth Estimates: 10

Sediment Depths: (5 to 10 measurements)

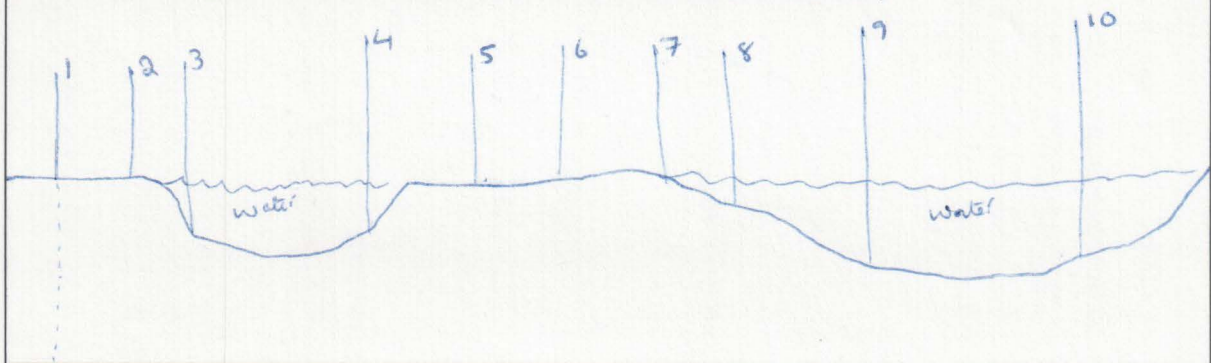
SO	15"	37"	3"	1.5"	11"	14"	31"	4"	4"	49"
WD	0	0	15"	7"	0"	0"	0"	3"	23"	17"

Site Sketch



☆ Not drawn to Scale

Cross Section (provide both horizontal and vertical measurements)



Notes (Photo Number and substrate description):

- 130 - whiteboard
- 131 - U.S. at transect
- 132 - D.S. at tra
- 133 - From RB to LB at transect
- 134 - Looking at RB
- 1) Few Gravel / Sand / Silt
- 2) Few Gravel sand / silt
- 3) Large gravel / sand
- 4) r -
- 5) Sand / Silt / gravel
- 6) Gravel / Sand
- 7) -- --
- 8) -- --
- 9) loose sand / gravel
- 10) sand / gravel